WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

E. A. BIRGE, Director W. O. HOTCHKISS, State Geologist

A. R. WHITSON, In Charge, Division of Soils

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE

H. L. RUSSELL, Dean

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SOIL SURVEY

OF

BUFFALO COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, T. J. DUNNEWALD, AND O. J. NOER

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

CLARENCE LOUNSBURY AND L. CANTRELL

OF THE

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* Scientist in Soil Survey, In charge of field operations in Wisconsin for the Bureau of Soils, U. S. Department of Agriculture.

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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their physical

character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity, and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis,* which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, course sand, and fine gravel, and the following table gives the size of the soil particles of which each group or separate is composed.

TABLE SHOWING SIZE OF SOIL PARTICLES

	Millimeters
Fine gravel	2.000–1.000
Coarse sand	1.000– .500
Medium sand	.500– .250
Fine sand	.250– .100
Very fine sand	.100– .050
Silt	.050– .005
Clay	.005– .000

1 millimeter equals .03937 of an inch.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay.—Less than 20% silt.

Soils Containing over 50% of Silt and Clay

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called *soil series*. It

corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

By uniting the name of the *soil class* which refers to texture, with the name of the *soil series* which refers chiefly to origin, we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF BUFFALO COUNTY, WISCONSIN.

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA.

Buffalo County, Wis., borders the Minnesota State line about midway between the south State line and Lake Superior. It is bounded on the north by Pepin and Eau Claire Counties and on

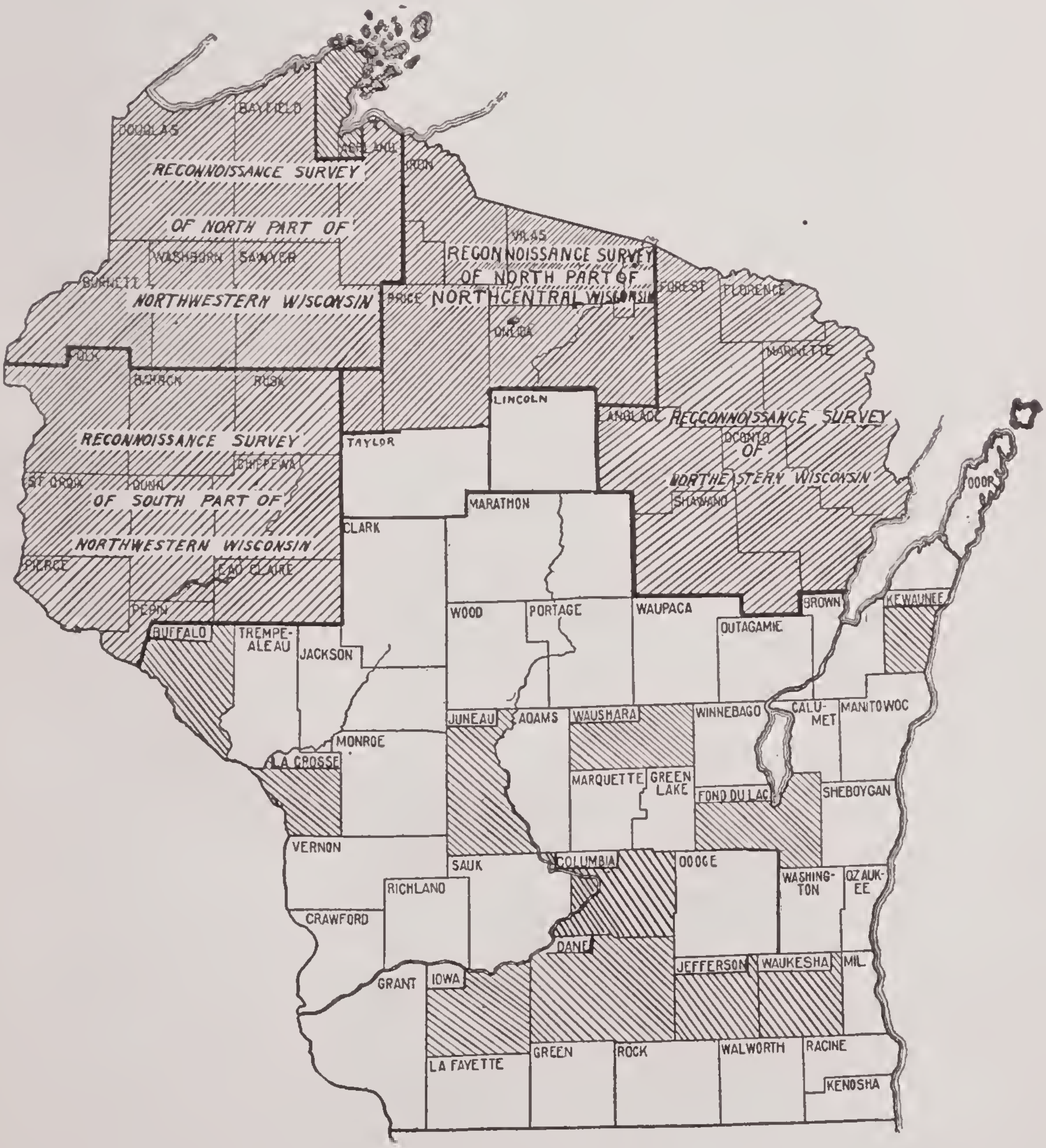

FIG. 1.—Sketch map showing area surveyed.

the east by Trempealeau County, the southern part of the eastern boundary line following the Trempealeau River. The south boundary line runs in a southeast and northwest direction, and

the county is separated from Wabasha and Winona Counties, Minn., by the Mississippi River. The northwestern part of the county is separated from Pepin County by the Chippewa River. The county is about 27 miles wide in the northern part and gradually tapers to a point at the southern extremity. It is about 38½ miles long, and has an area of 687 square miles, or 439,680 acres.

Topographically, Buffalo County consists of two plains, a lower and higher. The latter covers nine-tenths or more of the total area of the county, the former occurring only in the northeastern part as belts of lowland, one of them being followed by Buffalo River to Mondovi and continuing in about the same direction northwestward to the county line and beyond, and another, followed by Elk Creek. These are connected by a belt along Buffalo River south of Mondovi. This is a rolling and undulating plain lying about 300 feet below the level (1,100 feet) of the higher plain. It is the extreme western part of an extensive plain lying to the east, and has been formed on a soft sandstone of Paleozoic age. It is bounded by an escarpment terminating in a rather abrupt slope from the higher plain. The two branches of the lower plain are separated by an outlying remnant of the upper plain. The lower plain is the product of erosion in an advanced stage of development, and lies now at low relief.

The topography of the upper plain is hilly, due to complete dissection and it now stands in a stage of maturity.

According to the census of 1910, the population of Buffalo County is 16,006. The rural population is evenly distributed through the county.

Alma, with a population of 1,011, is the county seat. It is situated on the Mississippi River and has the advantage of both railroad and water transportation. Fountain City, with a population of 1,031, is also on the Mississippi River in the southern part of the county. Mondovi, with a population of 1,325, is the largest incorporated town in the county. It is situated on the Buffalo River, in the northeastern part of the county, and is the center of a prosperous agricultural community. Nelson and Cochrane are smaller places on the railroad, while Gilmanton, Montana and Waumandee are small villages off the railroads.

All the railway lines thus far built have kept to the valleys. There are thus considerable areas which are at some distance from shipping points. The Chicago, Burlington & Quincy Rail-

VIEW ALONG THE MISSISSIPPI RIVER.

In some places the bluffs come to the water's edge, while in other places the floodplain is several miles wide.

road, running from Chicago to Minneapolis and St. Paul, traverses the county, following close to the Mississippi River and passing through Fountain City, Cochrane, Alma, and Nelson. The Chicago, St. Paul, Minneapolis & Omaha Railway from Fairchild reaches into the northeastern corner of the county and terminates at Mondovi. A branch of the Chicago, Milwaukee & St. Paul Railway follows the Chippewa River to the Mississippi on the Buffalo County side, but is of little service to the county, since for most of its extent it lies within the flood plain of the Chippewa River, and is very difficult to reach. The extreme southern end of the county is crossed by a branch of the Chicago & North Western and also by the Green Bay & Western railroad. The distance from Alma to Minneapolis over the Chicago, Burlington & Quincy Railroad is 89 miles and to Chicago 353 miles. From Mondovi to Chicago over the North Western line the distance is 327 miles, and to Milwaukee 246 miles. The Mississippi River affords water transportation, but at present is used to a comparatively small extent.

The main dirt roads throughout the upland portion of the county are usually kept in good condition, as the predominating soil material naturally makes a good roadbed; but hills are numerous, and the grades are often steep, so that hauling heavy loads is difficult. Throughout sandy portions of the county, where foreign material has not been applied, the roads are naturally sandy. All parts of the county are supplied with rural mail-delivery service, and telephones are common throughout the country districts.

Local towns provide a market for varying quantities of farm produce and supply shipping points from which produce is shipped to outside markets. Winona, Minn., just across the Mississippi River, constitutes a market for produce from the southern part of the county. Minneapolis, St. Paul, Chicago, and cities within the State receive produce from Buffalo County.

Buffalo County lies in the unglaciated part of Wisconsin and in its geologic formations, topography, and soil conditions is representative of a very large area in the southwestern and western part of the State. Three general physiographic divisions are easily recognizable: (1) The uplands proper, which are gently undulating to strongly rolling and in places even steep and rough in topography; (2) the terraces and level valley areas

occurring in the position of terraces; and (3) the overflow plains of the present streams.

The soils in the last two divisions have been derived to a very large extent, if not wholly, from the soils of the first division and represent wash material transported by the streams and deposited in their flood plains. The material of the first bottoms is of recent deposition and the process is still going on; but those in the terraces are much older, some probably dating back to glacial time or before, with the result that through weathering the surface has come to be more like that of the uplands than that of the first bottoms.

The upland soils are predominantly silty, as is the case throughout the unglaciated area of the State. The great extent of silty soils has led some to believe that a blanket of wind blown material originally overspread most of the region and that the soils are derived for the most part from this deposit and are residual from the underlying formations which in an undecomposed state are now usually found at a depth of less than 15 feet from the surface and outcrop in many places. The silty material is of a rather smooth texture and comparatively free of stone or other coarse material, but it is just such material as would be expected to result from the mature weathering of the country rock, consisting of fine and cherty limestones, shales, and sandstones.

Over a large part of the county the uppermost rock consists of the lower Magnesian limestone. Once the limestone was continuous as the surface formation, but as the result of erosion which has deeply dissected and worn away much of the old plain, it is now found only as remnants capping the higher hills and ridges and giving way in all the lower levels to the Potsdam sandstone, the immediately underlying formation. The limestone and a massive phase of the Potsdam sandstone outcrop along the upper slopes and give rise to steep stony slopes and cliffs. At lower levels the principal rock is a thin-bedded sandy shale or shaly sandstone with occasional layers of a heavier shale.
underlain by limestone, characterized in general by a brownish-gray to brown silty soil underlain by a yellowish brown or buff-colored silty clay loam subsoil, are classed in the Knox series. The soils of the slopes below the limestone lying mainly on the sandstone and shale layers and which have been made up in part or wholly of materials derived from the sandstone, have been in-

cluded in the Boone series. Where these slope soils are distinctly dark in color, they are included in the Bates series. The Boone series includes a fine sandy loam and a fine sand. The Bates series, of which the area is small, includes a silt loam and a fine sandy loam.

Distinct terraces are developed in the Mississippi Valley and also in the larger tributary valleys. The terraces in tributary valleys are occupied largely by soils which are predominantly silty, with comparatively little sand, while in the Mississippi Valley and Chippewa Valley the greater part of the material outside of the present flood plain is of a sandy nature. This terrace material is classed with three series—the Waukesha, which is black or dark brown; the Lintonia, which is light colored and not underlain by gravel or other coarse material; and the Plainfield, which is light colored and rests upon a substratum of sand and gravel. In the Waukesha series there are two types, the gravelly sandy loam and silt loam. In the Lintonia series three types are recognized—the Lintonia silt loam, fine sandy loam, and fine sand; and in the Plainfield series three types—sand, fine sand, and fine sandy loam.

In many of the smaller valleys tributary to the Mississippi and Chippewa Valleys the present flood plain consists of a dark-colored material, variable in texture and color, and poorly drained. This material has been carried down from the unglaciated higher lands, transported by streams and redeposited. Such material is classed with the Wabash series, and in the present survey one type—the Wabash loam—is recognized and mapped. The soil of the present flood planes of the Chippewa and Mississippi Rivers which, in addition to being poorly drained, is subject to overflow by these streams at intervals, has been classed with the Genesee series. This series includes a fine sandy loam, silt loam, and silty clay loam.

On the steep slopes throughout the upland part of the county there are extensive tracts where the outcrops of rock are so numerous or the surface so steep and broken that the land is of no agricultural value except for the little pasturage it affords. Such land has been classed as Rough Stony Land and may be considered as non-agricultural.

A few low-lying acres occur in which the material consists of vegetable matter in various stages of decomposition. Such tracts are mapped as Peat.

The following table gives the name and the actual and relative extent of each of the soils* mapped in Buffalo County.

Soil	Acres	Per cent
Knox slit loam	104,256	47.6
Steep phase	105,216	
Rough stony land	62,912	14.3
Wabash loam	36,480	8.3
Genesee soils	31,872	7.3
Boone fine sandy loam	20,200	6.7
Rolling phase	1,984	
Waukesha silt loam	19,520	4.4
Lintonia silt loam	7,168	1.6
Bates silt loam	7,168	1.6
Boone fine sand	6,656	1.5
Peat	6,400	1.5
Plainfield fine sandy loam	6,0[illegible]0	1.4
Lintonia fine sandy loam	3,904	.9
Plainfield fine sand	3,776	.9
Plainfield sand	3,776	.9
Bates fine sandy loam	1,344	.3
Waukesha gravelly sandy loam	1,088	.2
Lintonia silt loam	640	.1
Total	439,680	....

* The soil classified in this report as Knox silt loam with its steep phase, includes what was mapped by the U. S. Bureau of Soils as Boone silt loam, with a rolling phase, and Union silt loam with a steep phase. The Waukesha silt loam and gravelly sandy loam were originally included in the La Crosse series. The Plainfield fine sandy loam and fine sand also include some soils previously mapped by the Bureau of Soils as belonging to the La Crosse series.

CHAPTER II.

LIGHT COLORED UPLAND SOILS.

Knox Silt Loam

Description.—The surface soil of the Knox silt loam to an average depth of 10 inches consists of a light-brown or grayish friable silt loam. When dry it has a smooth, floury feel. The amount of organic matter present in the soil is rather small, and this accounts, in part, for the light color. The subsoil consists of a yellowish-brown or buff-colored silt loam, which becomes heavier, more compact, and claylike with increased depth, until, at about 18 to 24 inches, it is a silty clay loam. The soil mantle extends to an average depth of probably 8 to 12 feet. The underlying rock was not reached with the soil auger except in local spots on a narrow ridge, at the edge of a bluff, or at the head of a ravine. Both soil and subsoil are practically free from stone, gravel, or other coarse material, although occasional fragments of chert are to be seen on the surface or in the subsoil close to the limestone rock. On account of the heavy subsoil and the uniformly silty character of the soil, the type is commonly referred to by farmers throughout the county as a clay.

The most important variation in this soil has been designated as the steep phase, on account of its steep slopes and rough, uneven topography. This phase is described in greater detail following the description of the typical soil.

Minor variations in the typical soil occur, chiefly on the narrow ridges, where the surface soil has sometimes been removed and the heavy subsoil exposed. In such places the depth to the underlying rock is also less than over the more extensive areas of this type and in some instances it can be reached with a 3-foot auger. On some of the lower slopes the wash from adjoining higher land has accumulated to a small extent, and the surface soil in such places is somewhat deeper than the average. On some slopes the soil is somewhat darker in color and contains more

organic matter than typical. While a number of such minor variations occur, this soil, taken as a whole, is remarkably uniform.

Extent and Distribution.—The Knox silt loam, with its steep phase, is one of the most important soil types in Buffalo County. It occurs in all parts of the county and occupies the limestone ridge tops of the entire upland portion of the survey. It lies at a higher level than any other type and includes all of the lands above the rough stony escarpments. It also covers many of the valley slopes descending to the level valley terrace soils.

Topography and Drainage.—The topography of the Knox silt loam as it occurs on the ridge tops may be classed, in most cases, as undulating to gently rolling. On the narrower ridges and at the heads of valleys it becomes more rolling and grades into the steep phase, while over portions of the broader ridges the surface is nearly level. That part of the typical soil occupying the lower slopes and lower outlying ridges is gently rolling, but often grades abruptly into the steep phaze or Rough Stony land.

On account of the fine texture and the peculiar structure of this soil a considerable proportion of the type is subject to erosion, and care must be exercised in selecting crop rotations and in the cultivation of all slopes, even though the slope is gentle. Some erosion will take place even on rather gentle slopes where intertilled crops are grown or where the ground is left bare and not cultivated for a considerable time. Wherever the slopes are so steep that intertilled crops can only be grown at intervals, or where no crops other than grass can be grown without danger of serious erosion, such slopes have been included with the steep phase.

Owing to the character of the topography, the natural surface drainage of the type is good, so that tile drains will doubtless never be necessary except possibly on some of the broader ridges, where the surface is more nearly level than elsewhere.

Origin.—The Knox silt loam has the uniform silty texture, the buff-colored subsoil, and other field characteristics of a loessial formation, though it is considered that part of the material has been derived from the underlying rock, the lower Magnesian limestone. The material forming this soil is sometimes found to be in a slightly acid condition. The subsoil is less acid than the soil, and frequently shows no acidity at all.

Native Vegetation.—The original timber growth on this type consisted chiefly of white, black, and bur oaks. Maple, poplar, hickory, white birch, and basswood are also commonly seen, and hazel brush is frequently abundant. Some of the older settlers state that most of the timber was originally on the ridges, and that many of the valleys were treeless, being burned over annually by the Indians, who used some of the land for grazing. Some of the wider valleys, with dark-colored slopes, were timbered sparsely with oak and were called "oak openings." Most of the timber which is now standing is confined to the steepest slopes and associated chiefly with the Rough stony land. Small wood lots are also seen on top of some of the narrow ridges.

Present Agricultural Development.—By far the greater part of the typical Knox silt loam is under cultivation and highly improved, while much of the steep phase is still in timber or pasture land. The leading type of agriculture followed consists of dairying in conjunction with general farming. As the growing of wheat, which was a very important industry 20 to 25 years ago, declined, the raising of live stock and the dairy industry gradually developed.

The principal crops grown at the present time and the average yields obtained are as follows: Corn, 40 to 45 bushels; oats, 35 to 45 bushels; barley, 30 to 35 bushels; wheat, 20 to 25 bushels; and hay, 2 to 2½ tons per acre. Oats are grown more extensively than any other grain crops. The acreage of barley is considerably smaller than that of oats and the acreage devoted to wheat is still less. The quality of the small grains grown on the Knox silt loam is excellent, and this soil is generally held to be a better grain soil than any of the other soils of Buffalo County. Corn, on the other hand, does not do so well on this type as on the darker colored soils of the Wabash or Waukesha series, though the crop is successfully grown wherever this soil occurs. Most of the grain and corn grown is fed to stock on the farms, though elevators at Alma, Fountain City, and Mondovi still ship much oats and barley and some wheat. Where the land is well farmed but little trouble is experienced in growing clover. When the snowfall is light the alternate freezing and thawing of the ground sometimes kills out clover. Pasturage, in general, is excellent, being scant only in very dry weather, or on shallow slopes or knolls exposed directly to the sun.

Buckwheat, rye, and sorghum are produced on this soil, but their acreage is never large. Alfalfa is successfully grown by a few farmers and the acreage will no doubt be gradually increased, as the crop provides excellent feed, which is of great value, especially to the dairy farmers. Potatoes are grown for home use on practically every farm, but seldom on a commercial scale. Tobacco is grown to a small extent, but the crop is not increasing in favor. Beans and peas are not extensively grown on this type, being confined chiefly to soils of lighter texture. Garden crops, such as strawberries, tomatoes, lettuce, radishes, and cucumbers, and bush berries all do well and are grown for home use, but seldom on a commercial scale.

The rotation of crops most commonly followed on the Knox silt loam consists of a small-grain crop, such as oats, barley, or wheat, with which clover and timothy are seeded, hay being cut for two years, after which the land is plowed for corn. A field may be pastured for a year, but on account of the large amount of steep land on most of the farms such land is used for pasture and the hay fields are not often grazed.

When the soil is cultivated under the proper moisture conditions but little difficulty is experienced in securing a good seed bed. If handled when too wet there is danger of puddling. Where the clay loam subsoil is near the surface or exposed on the narrow ridge tops, cultivation is more difficult than on the broad ridges where the surface soil has a good depth. Because of the rather low organic-matter content, the type is somewhat less loamy than some of the other silt loams. Practically the only fertilizer used on this soil is stable manure. A second crop of clover may be plowed under, but the practice of green manuring is not at all common. Fall plowing is practiced to some extent, and this is advisable where there is but little danger from erosion, but on slopes which are apt to wash it is better to plow in the spring.

While farming is well developed on this type and most farmers are prosperous, there is considerable room for improvement.

Land of this type has a considerable range in value, depending upon location, improvements, and the character of the surface. The best improved farms, conveniently located, and with a large proportion of their acreage on the broadest ridge tops, range in value from $75 to $100 an acre. Most farms include land of the steep phase of this type, and many include some Rough stony

land, which detract from their value. In some remote parts of the county, and where there is a large proportion of the steep land on the farms, values range from $30 to $60 an acre.

Knox Silt Loam, Steep Phase.—In general physical character and appearance the soil of the steep phase is essentially like the typical soil, the basis of separation being one of topography. As a whole the color and texture of the soil may be slightly lighter than the typical soil, and the average depth to rock is less. Because of its steep, broken character, this phase has a lower agricultural value than the typical soil.

The steep phase of the Knox silt loam occurs in all parts of the county intimately associated with the main type and frequently grading into it in such a way as to make the drawing of a definite boundary line difficult. It occupies steep slopes generally about the heads of small streams heading in the limestone areas above the Rough stony land. On these slopes, which form the more or less steep sides of the valleys, the silt soil is subject to erosion and careful methods are often necessary to prevent destructive ditch formations while these slopes are under cultivation. When the steep slopes are neither wooded, in pasture, nor covered by a growing crop to protect them, the soil washes badly and ditches are quickly and deeply cut into the hillsides. When erosion has once started in this way it is difficult to check, so that methods of prevention are very important.

The natural drainage of the steep phase is good, except in small areas along the slopes where springs and seeps may occur. The greater part of it is so rolling that too large a percentage of the rainfall runs off, and crops often suffer from lack of moisture.

The Knox silt loam, steep phase, has practically the same origin as the typical soil, though as a rule there is less depth to bedrock, and chert fragments occur on the surface and through the soil mass in greater abundance. As with the typical soil, it is partly residual from a cherty magnesian limestone and partly of loessial origin.

The original timber growth consisted of the same trees as on the typical soil, oak predominating. Most of the standing timber outside of the bottom lands is now found on this phase and on the Rough stony land with which it is associated, though a considerable proportion of the steep land is cleared and either in cultivation or pasture land.

The same crops are grown on the steep phaze as on the typical soil, but less corn and other intertilled crops are grown and more of the land is in grass and pasture than on the main type. The ordinary yields of all crops are somewhat lower. Because of the steep character of the surface the phase is more difficult to work than the typical soil. The steepest portions of the phase are now in timber or pasture land and the remainder is devoted to general farming.

Land values are subject to considerable variation. The phase usually forms only a portion of the farms, occurring in association with the typical soil and in some cases also with Rough stony land. It is estimated, however, that the value of this class of land alone would range from $25 to $50 an acre, depending upon the degree of slope and the area under cultivation, as well as upon the location and improvements.

Chemical Composition and Management.—Numerous analyses of the Knox silt loam indicate that it contains on the average about 900 pounds of phosphorus, 35,000 pounds of potassium and 2,700 pounds of nitrogen in the surface soil eight inches of an acre. Analysis of the timbered soil as compared with cultivated fields indicates that cropping reduced the content of phosphorus in the virgin soil to a considerable extent in some cases. The most severe drain on phosphorus was probably during the grain raising days of 30 or 40 years ago and the removal of this element of plant food is possibly not so rapid now under the dairy system of farming.

The total potassium is sufficient to meet the needs of crops for a long time to come, but the availability of the mineral for the use of plants can be greatly increased by having a supply of decomposing organic matter in the soil. The improvement of this soil as a whole calls for more organic matter and may be added in the form of green manuring crops turned under or as manure.

Many fields have become sour or acid on the surface through continued cropping, especially on the higher ridges, the soil in the valleys and on the slopes being supplied with lime dissolved by rain and flood water from the limestone which caps the ridges. Where trouble with clover or alfalfa is had, lime will be needed and such fields should be tested with blue litmus paper for acidity. Where the soil is acid a ton of finely ground limestone per

VIEW SHOWING LINTONIA SILT LOAM ON THE TERRACE JOINING THE STEEP SLOPES OF THE UPLAND.

On many of these steep slopes the soil is shallow, and the underlying rock frequently outcrops. Care should be taken to prevent erosion on such slopes when the timber is removed. The steepest slopes should be allowed to remain forested.

acre will be found to help clover, while for alfalfa 2 tons or more should be used.

The question of erosion is an important one on this type of soil and especially on that part designated as steep phase. In many cases the loss of organic matter and phosphorus from the soil by erosion is considerable, and often the fertility and yields on some fields could be greatly improved by proper attention being paid to the arrangements of the fields and crops and the protection of the fields from erosion.

When the slope becomes so steep that the bare ground washes to any extent, care should be used to keep that field in hay or pasture as much as possible or it should be laid out in alternate strips of cultivated crop and sod land if practicable. Where the slope is so steep that modern farm machinery cannot be used, cultivated crops should seldom if ever be grown. When timbered such slopes should remain so and be used for pasture only. Badly eroded slopes can be restored by proper cropping and management. For further data on erosion see Bulletin 272 of the Wisconsin Experiment Station.

Chemical analyses of Lintonia silt loam show it to contain on the average slightly more of the essential plant food elements than occur in Knox silt loam which it very much resembles in texture, structure, and color. Suggestions offered for the improvement and management of the Knox silt loam will also apply to this type of soil except as regards erosion. While this soil is eroded in some cases, the topography being level sheet erosion does not often occur, and methods for combatting gullies only are necessary.

LINTONIA SILT LOAM.

Description.—The surface soil of the Lintonia silt loam to an average depth of 10 inches consists of a brownish-gray, friable silt loam, which becomes lighter colored on drying and frequently has a whitish appearance. The amount of organic matter present in the surface soil is comparatively small, and this accounts in part for the light color of the material. A slight acid condition has developed in places in the surface soil, as indicated by the litmus-paper test. The subsoil consists of a yellowish-brown or buff-colored silt loam, which usually becomes somewhat heavier and more compact with depth, and at 24 to 30 inches may be

a silty clay loam. Below this depth there is often a considerable amount of fine and very fine sand, and this mixture extends to a depth of 3 feet or over and grades into stratified fine sand, with layers of gravel in the lower depths. The type is subject to some variation, and in Glencoe Township and the valley of Buffalo River the soil is somewhat darker than typical.

The soil quite closely resembles the Knox silt loam in texture and color, but differs from it in topography, origin, and the position which it occupies.

Extent and Distribution.—The most extensive areas of Lintonia silt loam are found in the Buffalo River Valley in the vicinity of Tell, where terraces of this soil have a width of from one-half to three-fourths of a mile, and these frequently extend back to tributary valleys for 1 mile to 3 miles. A number of areas also occur in Little Bear Creek Valley in the northwestern part of the county. Lower Big Waumandee creek valley and tributaries, and tributary valleys of the Trempealeau River in the southeastern part of the survey also contain quite extensive remnants of Lintonia silt loam terraces.

Topography and Drainage.—The surface of the Lintonia silt loam is usually level or nearly so, frequently having a gentle slope toward the stream channels along which it occurs. The type occurs as terraces, usually rather narrow, but extending along the streams for considerable distances. The part adjoining the upland rises slowly and frequently grades into the Knox silt loam so gradually that the boundary line must be arbitrarily placed. Near the Mississippi Valley the terraces of this soil have an elevation of 20 to 30 feet above the present flood plain, but as the distance back from the Mississippi River increases, the elevation of the terraces above the flood plain becomes less, and the difference finally is not over 4 or 5 feet. As this type is found chiefly at the foot of considerably higher lying slopes, which are often very steep, large quantities of water must pass over the terraces during heavy rains, and as a result deep ravines are frequently formed. Such gullies may become a source of great expense and loss to individual farms. The natural drainage of this type is usually good, but there are a few places where the surface is nearly level, and in places over such tracts tile drains could be installed to advantage.

Origin.—The material composing the Lintonia silt loam is largely of alluvial origin and was deposited during glacial

periods when the melting ice sheets greatly increased the volume of water flowing down the Mississippi River and many of its tributaries. The high water in the Mississippi River itself caused a backwater or partly ponded condition in the tributary streams. In these more or less quiet waters the finer particles now forming the soil were deposited. The coarser particles in the deep subsoil were deposited earlier, before the ponded condition prevailed and when the current was swifter. It is probable that a portion of the surface material, especially close to the foot of the bluffs, is partly colluvial, having been washed down the steep slopes from the Boone and Knox silt loam areas, which are always found at a higher elevation.

The gravel in the Lintonia terraces is of glacial origin. In the valley of Buffalo River such gravel is found as far up as Mondovi, though none is found in this valley more than a mile east of Mondovi. Such gravel, however, is found in the valley of Farrington Creek to the west of Mondovi.

Native Vegetation.—The original timber growth on the Lintonia silt loam consisted chiefly of oak, with some hickory and a few other species. Most of the timber has been removed. In the ravines there is now a second growth of sumac, hazel, and other brush.

*Present Agricultural Development.**—Practically all the type, except the more eroded areas, is put to some agricultural use, and most of it is cultivated regularly. The land where erosion is most active is kept in pasture most of the time, or the grass may be cut for hay. The crops generally grown and the yields obtained are: Corn, 45 to 50 bushels; oats, 25 to 40 bushels; barley, 30 to 35 bushels; and hay, 1½ to 2 tons per acre. Potatoes are grown on the type to a small extent for home use, but seldom on a commercial scale. The usual rotation consists of corn followed by a small grain, either oats or barley, or sometimes by one year of each of these crops, and then by clover and timothy mixed, seeded with the grain, the field being cut for hay one or two years, before returning to corn. The stable manure is usually applied to the sod to be plowed under for the corn crops. The methods of cultivation, fertilization, and treatment are practically the same as those practiced on the Knox silt

*For chemical composition and management see the discussion on composition of Knox silt loam on page 22.

loam. The soil is not difficult to cultivate, and where the areas are of sufficient size to form fields or the larger part of a farm, this terrace soil may be considered one of the most desirable types in the county.

Farms made up largely of soil of this type sell for $50 and $80 an acre, depending upon the location and improvements.

CHAPTER III.

DARK COLORED UPLAND SOILS.

WAUKESHA SILT LOAM.

Description.—The surface soil of the Waukesha silt loam to a depth of 12 to 18 inches consists of a dark-brown or black silt loam containing a high percentage of organic matter. Its high percentage of silt and organic matter gives the soil an extremely smooth feel. The subsoil consists of a brown or buff-colored silt loam, which gradually becomes heavier in texture and lighter in color and at 24 to 30 inches consists of a yellowish-brown, compact, heavy silt loam or silty clay loam. In local areas where the drainage is deficient the subsoil shows a slight mottling of light gray or drab. This heavy subsoil extends to a considerable depth and the soil section will probably average 7 to 8 feet in thickness. Below this heavy mantle are to be found stratified beds of sand. Along the Mississippi and Buffalo Rivers and Farrington Creek some glacial gravel may also be found with the sand.

Extent and Distribution.—The largest areas of this soil occur in Little and Big Waumandee Valleys, where it is most typically developed. In the vicinity of Anchorage the black soil occupies most of each valley for a distance of 6 or 7 miles. The area varies in width from one-fourth to three-fourths of a mile. A comparatively extensive area is mapped also at the mouth of Schultz and Newton Valleys west of Mondovi and in Farmington Valley northwest of Mondovi. Strips of this type about one-fourth mile in width and from 1 mile to 3 miles in length are found in a great many of the smaller tributary valleys scattered over the county.

Topography and Drainage.—The surface of the Waukesha silt loam is level or has a very gentle slope toward the streams along which it occurs. In places it occupies a distinct terrace and lies about 6 to 10 feet above the present flood plain of the stream, while in other places it occupies an entire valley floor through

which the stream has cut its channel, with the present water level from 3 to 10 feet below the surface of the type. Natural drainage over most of this type is fairly good. A few of the lower areas are subject to overflow during the heavy rains of spring, but by far the greater proportion is not subject to inundation. A considerable part of the type would be benefited by tile drains, though these have not been installed to any great extent. Because of the gentle slope or level character of the surface, there is no danger of erosion.

Origin.—The material composing the Waukesha silt loam is of alluvial origin and occurs in the valleys of many streams throughout the county. The upper section, consisting largely of silt, was deposited in comparatively quiet waters, but the beds of sand forming the lower section were deposited by more rapidly moving currents. The dark color of the soil is due to the large content of organic matter resulting from the growth and decay of rank vegetation in the presence of moisture.

Native Vegetation.—The native vegetation consists largely of grasses, with some timber, mainly oak, elm, and soft maple. The greater part of the merchantable timber has been removed.

*Present Agricultural Development.**—Practically all of the Waukesha silt loam can be cultivated, and the greater proportion of it is now in farms and well improved. It is one of the most highly valued soils of the county, and with the soils of the Bates series comprises the best corn land. The yields of corn range from 60 to 80 bushels per acre during favorable years, and the ordinary yields are larger than those from the other types in the county. The small grains do well, but the quality is not so good as that of grains grown on the Knox silt loam. Oats and barley each yield about 40 to 45 bushels per acre. An excessive quantity of straw is apt to be produced and these grains, especially oats, are likely to lodge. Clover and timothy do well and pasturage is always good.

A rotation frequently followed consists of corn followed by small grain for 1 or 2 years and then hay for 2 years. Corn is often grown on the same field for 2 or 3 years in succession, and on the whole not enough consideration is given to the rotating of crops. Because of the natural fertility of this soil farmers

*For chemical composition and management of this type of soil see page 33.

have abused it. Cropping has been heavy and in many cases no element of fertility has been returned to the soil.

The Waukesha silt loam is not difficult to handle under proper moisture conditions, but it can not be worked under so wide a range of moisture conditions as the Bates silt loam, which has better drainage. Where the soil is well drained alfalfa can be successfully grown.

Land of this character brings from $80 to $150 an acre, depending upon location and improvement.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Waukesha silt loam:

MECHANICAL ANALYSES OF WAUKESHA SILT LOAM

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Soil	0.0	0.3	0.4	1.6	10.9	73.4	13.4
Subsoil	.0	.1	.2	.6	11.4	72.3	15.4

BATES SILT LOAM.

Description.—The surface soil of the Bates silt loam to an average depth of 12 to 14 inches consists of a heavy, black to dark-brown silt loam. The amount of organic matter in the surface soil is large, and the material has the smooth feel characteristic of silt. Litmus-paper tests indicate that the soil is in an acid condition. The subsoil consists of a heavy silt loam of a brown or chocolate-brown color, which gradually becomes lighter in color with depth. At 24 to 30 inches the material becomes a yellowish-brown, slightly sticky, heavy silt loam. Below this depth it frequently becomes lighter in texture and at 40 inches there is usually an appreciable amount of fine and very fine sand. On the higher slopes and tops of knolls the soil is lighter in color than elsewhere, and in such locations the surface material has been eroded, leaving the subsoil exposed. On some of the lower knolls underlain by sandstone the soil is thin and there is more or less coarser material mixed with it, giving it a somewhat sandy texture.

Extent and Distribution.—The Bates silt loam is of small extent, the largest areas occurring directly north of Mondovi, occupying the sloping land bordering Big Bear Creek Valley, along the North Fork of Elk Creek, and the valleys of Big Waumandee and Kammuler Creek. Other scattered areas of small extent occur in various parts of the survey.

Topography and Drainage.—The position which the type occupies is intermediate between the Waukesha silt loam of the terraces and the Knox silt loam of the highest parts of the country. It occupies gentle slopes and even rather rolling upland areas, but these are always parallel with the alluvial valleys and immediately bordering them. The type grades into Waukesha silt loam on the one hand and Knox silt loam on the other, so that there is quite a range in the color of the material. On account of the sloping surface, the natural drainage is excellent, while the slopes are seldom steep enough to cause any considerable damage from erosion.

Origin.—The silty material composing this type of soil is probably of residual origin from a shaly phase of the Potsdam formation or it may be partly loessial. It differs from the Boone silt loam principally in its higher organic-matter content.

Native Vegetation.—The type as a whole is generally known as "oak openings," having been originally timbered with scattered clumps of large oak trees, while the intervening spaces were in a semiprairie condition, supporting a more or less heavy growth of prairie grass.

*Present Agricultural Development.**—The Bates silt loam is one of the desirable types of soil in the county. Because of its great natural fertility, it frequently has been ill used, too little attention being given to crop rotation and fertilization. All the general crops grown in the region do well on this type, and the average yields of some of the crops are considerably higher than on most of the other soils. The soil is especially well adapted to corn, of which the ordinary yield is 50 to 60 bushels an acre. This type and the Waukesha silt loam are the two best corn soils in the county. Barley produces 30 to 35 bushels and oats 30 to 40 bushels per acre. Wheat is still grown to some extent and yields of 25 to 30 bushels per acre are not at all uncommon. The quality of the small grains is not so good as of those grown on the

*For chemical composition and management see page 33.

Knox silt loam. Clover and timothy produce 1½ to 2 tons per acre, and the pasturage is generally excellent. The rotation of crops most generally followed consists of corn, small grains, and hay. Of the small grains, oats is most commonly grown, though barley may also be grown in the rotation following the oats. A few small fields of alfalfa have been established on this soil. Where the acid condition is corrected and the soil inoculated this crop promises very well.

Dairying is the chief branch of farming followed, and hog raising is carried on quite extensively on many of the dairy farms. The buildings and other improvements on this soil are as a rule better than the average. Silos are in quite general use.

Farms located on land of this type have a selling price ranging from $75 to $100 an acre, depending upon improvements and nearness to markets.

Below are given the results of mechanical analyses of samples of the soil and subsoil of the Bates silt loam:

MECHANICAL ANALYSES OF BATES SILT LOAM

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Soil	0.0	0.4	0.4	1.4	13.2	68.5	15.9
Subsoil	.0	.2	.2	1.5	16.6	66.7	14.9

BATES FINE SANDY LOAM.

Description.—The surface soil of the Bates fine sandy loam to an average depth of 10 to 12 inches consists of a dark-brown to black fine sandy loam, which contains a large amount of organic matter. When dry the material has a dark-grayish appearance. Litmus-paper tests usually indicate an acid condition. The subsoil consists of a choclate-brown fine sandy loam or loam which becomes lighter in color with depth. At 22 to 24 inches it is frequently a heavy silty loam, and sometimes is quite clay-like in appearance. At 38 or 40 inches the material is usually a yellow fine sandy loam.

The soil is subject to some variation and over small areas ranges from a fine sandy loam to a loam in texture, although the greater proportion of the material is a fine sandy loam.

Extent and Distribution.—The Bates fine sandy loam is one of the minor types of the county, occupying only 2.1 square miles. Nearly all of this type is found on the slopes bordering the south side of the Buffalo River Valley east of Mondovi. Here it occurs as a narrow strip from one-fourth to one-half mile wide, paralleling the valley in an east and west direction for nearly 4 miles.

Topography and Drainage.—This type occupies the lower portion of a long, gently rolling, residual fine sandy loam slope which leads down to the valley from the limestone ridges 3 miles south. The surface of the type is gently undulating and nearly level in places, but usually has a gentle slope toward the river. In a few places it is gently rolling. Because of the texture of the soil and the gentle sloping surface, the natural drainage is good, and there is no serious danger from erosion.

Origin.—While the field work was in progress some doubt was felt as to whether or not this type was in part an old alluvial terrace formation, but because of the undulating to gently rolling surface and the fact that sandstone was found outcropping at its lower edge along the river bottom, the soil was mapped as an upland type and placed in the Bates series.

No evidence of stratification in the subsoil was found, although the soil section has an average depth to the underlying sandstone of 15 to 20 feet.

Native Vegetation.—The original growth of oak on this type was more evenly distributed than on the Bates silt loam, and it appears that no portion of the type was in the condition of prairie.

Present Agricultural Development.—Practically all of the type is now under cultivation, and it is considered a valuable soil. Dairying and hog raising is the leading type of farming, and this is carried on in conjunction with general farming. Corn produces 50 to 55 bushels, oats 35 to 40 bushels, barley about 25 bushels, and clover 1½ to 2 tons per acre. For a long period wheat was the most important crop grown on this soil and yields of 15 to 18 bushels per acre were obtained. The acreage of wheat at present is very small. This is a very good corn soil, ranking with the Bates and Waukesha silt loams in this respect. It is also well adapted to a number of truck crops, but trucking has not been developed to any extent. The soil is easy to cultivate. About the same methods are followed as on the silt loam.

Land of this type sells for $65 to $90 an acre, depending upon such factors as location and improvements.

CHEMICAL COMPOSITION AND MANAGEMENT OF DARK COLORED UPLAND SOILS

These dark colored soils are naturally the most fertile soils in the area. They are generally well supplied with the essential plant food elements and with organic matter which gives them their dark color. The total amount of phosphorus in the surface 8 inches is approximately 1,500 pounds per acre. The total potassium is 35,000 pounds, and the nitrogen from 4,500 to 5,500 pounds per acre 8 inches. Many fields on these soils which have been cropped for some time will in all probability be benefited by the use of a phosphorus fertilizer in addition to the use of manure.

These soils all show some acidity, although it varies with the location and past treatment of particular fields. Where clover and alfalfa do not do well the soil should be examined for acidity and if acid an application of 1,500 to 2,000 pounds of ground limestone per acre to the sour fields will be found beneficial.

Lying at lower levels than the upland soils, these soils often receive the run-off water from higher land, and level or low spots especially need drainage or special methods for taking care of storm water. In some cases tile drainage would be beneficial, in others surface ditches rightly placed would keep the land dry.

On account of their level topography and large content of organic matter, these soils are especially adapted to corn, hay, and other root crops. Grain crops often give large yields, but the quality is often not as good as on the lighter colored soils and oats and barley often lodge badly on these soils. This characteristic varies greatly with the character of the season. In case of low yields on well drained fields, the use of a phosphate fertilizer would hasten the maturity of crops.

CHAPTER IV.

LIGHT COLORED FINE SANDY LOAM SOILS.

BOONE FINE SANDY LOAM.

Description.—The surface soil of the Boone fine sandy loam to an average depth of 8 to 10 inches consists of a grayish-brown fine sandy loam, which in some places contains a considerable amount of medium sand. The amount of organic matter present is not large, but a slightly acid condition is found to exist over most of the type. The subsoil consists of a brown to yellowish-brown fine to medium sandy loam, which usually extends to a depth of over 3 feet.

Both soil and subsoil of this type are subject to considerable variation, though none of the variations are found of sufficient extent or importance to be mapped separately, except the more rolling tracts, which are usually shallow. This variation has been termed the rolling phase and shown separately on the soil map. In smaller sandy areas in the valleys of Bygolly and Little Bear Creeks the subsoil is a brown sandy loam, becoming lighter in color with depth and containing a few small bits of sandstone. Bordering Buffalo River in T. 24, R. 11, in the northern part of the county the soil is slightly finer and heavier than usual, varying from a fine sandy loam to a loam, and often grading into a compact sandy clay loam layer at 18 to 24 inches. This heavy material is again underlain by a yellow sand at 24 to 40 inches. The differences in texture are due in part to the presence of a shaly sandstone layer under the soil in places and also to the proximity of heavier and higher lying soils from which finer particles are often washed. Outcrops of sandstone are not uncommon, though they are not extensive and seldom interfere to any marked extent with cultivation. The depth to the underlying rock is variable, and while it averages considerably over 3 feet, there are places on the tops of ridges and on knolls where there may be as little as 2 or 3 inches of soil. There are also places

over gently rolling tracts where the soil has a depth of only 2 or 3 feet, but such areas are not extensive.

Extent and Distribution.—The Boone fine sandy loam is one of the important types in the county, though there are several which are more extensive. The largest area occurs in the northeastern part of the survey in Naples and Mondovi Townships, lying mostly south of the Buffalo River. A number of smaller tracts are found in the vicinity of Gilmanton along the slopes on the south side of Elk Creek and its two chief branches. Other small tracts are scattered throughout the northwestern corner of the county, and to a more limited extent through the southern part.

Topography and Drainage.—The surface of the Boone fine sandy loam, including the rolling phase, varies from undulating to rolling, and in places it becomes quite steep, though there are but few small areas where the surface is too steep to prevent the growing of the ordinary farm crops. Where the limestone cap remains with sandstone outcropping below, a rather steep, narrow belt of fine sandy loam following the contour is produced, as at the base of the river bluffs at Cochrane and Fountain City. Where the limestone covering is thinner, and where more of the sandstone is exposed, as in Little Bear Creek and Spring Creek Valleys and a few other places, long gently rolling or undulating slopes are found, being rather steep or rolling only near the limestone ridge. In the largest area in the northeastern part of the county, where the limestone capping has been entirely removed, the topography is nearly level in places. The surface rises with a gentle gradient up to long, gently rolling slopes, culminating in low, rolling, oak-timbered knolls, which slope away again to the next valley. The surface of this soil becomes rolling also and even rough in places along the southern edge of the area bordering the outliers of the limestone ridges which project into this type. South of Gilmanton, bordering Elk Creek Valley, is an irregular area of this type covering 3 or 4 square miles where the topography varies from gently rolling to rough and broken.

Because of the sandy nature of this type and its absorptive capacity it withstands erosion fairly well. On some of the steeper slopes, however, and over long, more gentle grades, where the run-off from an extensive area converges, there is some danger from erosion.

On account of the sandy character of the soil and the surface features, the natural drainage of this type is excellent. Where the soil is shallow and where the slopes are steep the type frequently suffers from lack of sufficient moisture, though as a whole it retains moisture fairly well.

Origin.—The original Boone fine sandy loam is largely residual, having been derived from the weathering of the Potsdam sandstone and from a shaly phase of this formation. On some of the slopes it is probable that some of the sandy material has been moved short distances down the slope by washing. Where there is silty material incorporated with the soil it is probable that a part of this has been washed down from higher lying silt loam types. Thus it will be seen that the type may also be partly of colluvial origin, though this phase is of minor importance. In a few places sand dunes have been formed, but these are also of small extent.

Native Vegetation.—The original timber growth consisted partly of black and scrub oak covering the shallow knolls and the lighter portions of the type. On the heavier portions there was some birch and maple. Sumac, hazel brush, poplar, and wild cherry form the second growth in uncultivated places.

*Present Agricultural Development.**—By far the greater proportion of the type is put to some form of agricultural use, and most of it is cultivated. The wooded portion is confined chiefly to the steeper slopes and shallow knolls, which are covered mainly with small oak. As is the case with the county as a whole, most of the type is devoted to general farming, with dairying as the most important branch. In connection with dairying quite a number of hogs are raised. The chief crops grown and the ordinary yields are as follows: Corn, 40 to 50 bushels; oats, 30 to 40 bushels; barley, 35 to 40 bushels; and hay from 1 to 2 tons per acre. Some rye is also grown and it gives fair yields. On some of the level portions of the type some farmers report an increasing difficulty in getting a good stand of clover. Others on the gently rolling phase report no trouble at all, none having been lost in the last seven or eight years. Some very fine stands of clover appear on some of the lighter portions of the type, even though the soil showed a slight indication of acidity in response to the litmus-paper test.

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*For chemical composition and management see page 41.

When the county was first settled wheat was grown extensively on this soil, but very little is now produced. It is considered a fair corn soil, and the yields are practically the same as on the Boone silt loam. Potatoes can be grown successfully, though the acreage is not large.

The rotation of crops most commonly practiced consists of corn, followed by oats or barley, with which clover and timothy are seeded. Hay is cut for one or two years, and the field may be pastured for a year before being again plowed for corn. Cultivation of this soil is not difficult, and a lighter class of implements and stock can be used than on the silt loam type.

The selling price of land of this type is quite variable, depending upon location, character of the surface, texture of the soil, and improvements. In the area near Mondovi the gently sloping and nearly level portions of the type sell for \$60 to \$100 an acre. The rougher places which are more distantly removed from towns are held at \$40 to \$50 an acre. In Little Bear and Spring Creek Valleys the price of land of this class ranges from \$25 to \$50 an acre.

Boone Fine Sandy Loam, Rolling Phase.—The rolling phase of the Boone fine sandy loam is separated from the typical soil for two reasons. In the first place the topography is more rolling than the typical soil and in the second place the depth of the soil material to the underlying rock is less than the average for the type as a whole. Because of these two conditions the agricultural value of the phase is considerably lower than that of the typical soil. In fact a considerable proportion of the rolling phase has been left wooded because of its lower value.

In texture the rolling phase is a somewhat lighter fine sandy loam than the main portion of the type, and the depth to rock, which is mostly the Potsdam sandstone, ranges from 1 foot to 3 feet. A few rock outcrops occur, but these are not extensive. The surface of the phase is nowhere found to be so steep as the steep phase of the Knox silt loam, but may be described as consisting of rather low ridges with gentle slopes and as regions where the topography is gently rolling to rolling. Some of the narrow areas of this type found bordering Knox silt loam or Rough stony land have been included with the rolling phase.

The rolling phase has the same origin as the typical soil and the original vegetation is the same. Where this class of land has been cleared the yields are lower than usual for the type, the

soil is more subject to drought, and as a whole is less desirable for farming. That which is now in timber should be allowed to remain so, and where cultivated the most careful methods of soil management should be practiced in order that the productivity may be increased.

PLAINFIELD FINE SANDY LOAM.

Description.—The surface soil of the Plainfield fine sandy loam to an average depth of about 14 inches consists of a reddish-brown heavy fine sandy loam. At about 16 to 20 inches the color becomes a lighter reddish-brown fine sandy loam, and this grades into stratified yellow fine sand at from 24 to 36 inches. Gravel occurs in places in the subsoil of this type south of Mondovi. While this is about the normal for the type, there are a number of variations, and the texture may range from a heavy fine sandy loam to a medium, and in a few places a rather coarse loamy sand. Some variations in color also occur, these ranging from dark brown to nearly black in places. None of the variations, however, were of sufficient extent to be indicated on the soil map.

Extent and Distribution.—The largest and most important area of this type is a long terrace lying between the bluffs and the Mississippi River in the vicinity of Cochrane. This belt varies in width from one-half to a mile, parallels the river for a distance of 6 or 7 miles, and has an elevation above the flood plain of 5 to 20 feet. The texture and organic matter content of this area vary somewhat, it being more sandy and of a lighter color on the side bordering the river than next to the bluffs. The soil occurs also as a narrow belt occupying a terrace bordering the Buffalo River in the northeastern part of the county. A few smaller tracts are found in various stream valleys throughout the county.

Topography and Drainage.—The Plainfield fine sandy loam is a terrace soil and the surface is usually level or slopes gently toward the streams along which it occurs. There are a few places, however, where the surface is undulating or even gently rolling, though such tracts are of small extent. On the whole the type has good drainage, but there are a few places where the surface is lower than usual and in these there is an excess of moisture during part of the year. On the other hand, some of the

lighter textured higher places are apt to suffer at times from drought.

Origin.—This is largely an alluvial soil, the materials having been deposited by the streams when flowing at a much higher level than at present. It is noncalcareous and the type is now slightly acid.

Native Vegetation.—A forest, largely oak, with some elm and soft maple in the lower places, originally grew on this soil. The growth was rather open, with grass among the trees. Some portions of the type were originally in a semiprairie condition.

*Present Agricultural Development.**—By far the greater proportion of the Plainfield fine sandy loam is under cultivation. It is considered a good farming soil. The chief crop grown is corn, which yields 45 to 50 bushels an acre. Oats yield 35 to 40 bushels an acre and barley about 30 bushels. A small acreage of wheat is grown and yields of 20 to 25 bushels an acre are obtained. The yields given above are for the average development of the type. On the more sandy tracts they are somewhat lower, and on the areas of heavier texture they are higher than indicated. This is especially true of corn. Timothy and clover are grown and alfalfa has been tried, but not extensively. Potatoes do well on this class of soil, and it would seem that this crop could well be grown more extensively.

Land of this type sells for $35 to $40 an acre, depending upon location, improvements, etc.

LINTONIA FINE SANDY LOAM.

The surface soil of the Lintonia fine sandy loam consists of 10 inches of light-brown or grayish-brown fine sandy loam which contains only a comparatively small amount of organic matter and which is acid in some places. The subsoil is a yellowish-brown, compact fine sandy loam to a depth of 24 to 30 inches, where the texture and color usually become lighter. In a few instances a layer of compact clay loam was found at 24 inches. This lighter material, which would be classed as a loamy fine sand in most instances, extends to 36 or 40 inches or even deeper, where stratified fine sand is usually found. The terraces upon which this soil is found are often 25 to 30 feet high, and in such places this stratified material extends at least to this depth.

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*For chemical composition and management see page 41.

The soil is somewhat variable in texture and in some places, especially on the higher elevations, the surface material is a loamy fine sand. In its texture the type is quite similar to the Boone fine sandy loam, and it is subject to about the same variations.

The Lintonia fine sandy loam is of limited extent and occupies only 6.1 square miles. The largest areas are those bordering the Buffalo River south of Mondovi and along the south side of Farrington Creek west of this place. There is also some of the type in Kammuler Valley north of Fountain City. Small tracts occur in various other places in the county.

The surface of this type is level or gently sloping toward the stream channel along which it occurs. The terrace which the type occupies has the same position and drainage conditions as the terraces of Lintonia silt loam, and this soil is subject to the same danger from erosion. The material composing the soil is also of the same origin, having been deposited when the waters were flowing at a much higher level than at present.

The original timber was chiefly scattered oak, but practically all of this has been removed, except where erosion has rendered the land unfit for cultivated crops.

The greater proportion of this type is under cultivation. It appears that the crop returns are somewhat better from the small areas of this soil in the small valleys than from the larger tracts found in the valley of the Buffalo River. Practically all of the crops common to the region are grown on this soil. Corn yields 30 to 50 bushels; oats, 25 to 40 bushels; barley, 25 to 30 bushels; and clover, 1 ton to 1½ tons an acre. While the soil was frequently found to be in an acid condition by the litmus-paper test, no difficulty was reported by the farmers in getting a stand of clover, except during dry years. Rye is grown, but not so extensively as oats or barley. Fairly good yields are obtained. During ordinary seasons good crops of corn and fair crops of hay are always had. When the rainfall is scanty, however, the soil suffers from the lack of moisture and crop yields are reduced to a greater extent than on soils of heavier texture.

The rotation most commonly followed consists of corn, small grain, and hay. Potatoes might be added to this list. The type is also well suited to small fruits, strawberries, and a number of truck crops.

CHEMICAL COMPOSITION AND MANAGEMENT OF LIGHT COLORED FINE SANDY LOAM SOILS.

The chemical analysis of the soils of this group shows them to be intermediate in chemical composition as well as in texture and value between the light colored heavy upland soils and the light sandy soil group. The total amount of phosphorus in the surface 8 inches is about 800 pounds per acre, of potassium about 20,000 pounds, and of nitrogen from 1200 to 1600 pounds.

Varying degrees of acidity are found on these soils and where best results are not obtained with clover and alfalfa, it will be advisable to apply 1500 to 2000 pounds of ground limestone per acre.

In improving these soils it is necessary first to see that the supply of organic matter is increased. This may be accomplished by growing green manuring crops of which the legumes are best—such as clover, the second crop of which should be plowed under before ripening. The supply of stable manure is often too limited and mineral fertilizers in addition to green manuring crops will be found to increase crops in such cases. Phosphorus in the form of acid phosphate applied at the rate of 300 pounds per acre once in 3 or 4 years will supply the plant food needed. By applying phosphorus and lime any trouble with clover or alfalfa should be overcome and when once these crops are successfully growing the greatest difficulty in building up soil has been overcome.

These soils are adapted to a variety of crops. Corn and small grains do very well but dry weather often injures crops such as grass and clover on these soils more than on the deeper and heavier soils. They are also adapted to potatoes and other truck and garden crops. A rotation which gives good results consists of small grain, followed by clover—the first crop for hay and the second plowed under. Next year corn or potatoes are grown. When the organic matter content has been sufficiently increased or when there is plenty of manure, the second clover crop can be cut for hay or ripened for seed.

CHAPTER V.

GROUP OF LIGHT COLORED FINE SANDS AND SANDS.

LINTONIA FINE SAND.

The surface soil of the Lintonia fine sand consists of a light-gray or yellowish loose fine sand extending to a depth of about 8 inches. This is underlain by a yellow loose fine sand which extends to a depth below the reach of the soil auger. In texture, structure, and color this type is quite similar to the Boone fine sand, but differs from that type in origin and topography. Like the Boone fine sand, it contains only a very small amount of organic matter and is in an acid condition.

The Lintonia fine sand is of very small extent and minor importance in the present survey. It covers only 1 square mile, the largest area occurring in the northeastern part of the county along the south side of the Buffalo River. It occupies a terrace position between the present flood plain and areas of Boone fine sand.

The surface of this type is nearly level to gently undulating, with a gradual slope toward the Buffalo River. On account of the loose structure the natural drainage is excessive and the soil is droughty. While the type occupies a position above the present flood plain, the elevation is never so great as that of the other types of this series, which also occur as terrace soils.

As indicated above, the type occupies a low terrace and the material composing it is of alluvial origin. Possibly a small amount of material has also been washed down from the higher land adjoining, but the proportion of the type that is of colluvial origin is small.

The original timber was chiefly oak, but the growth was rather scattering.

At present nearly all of the type is under cultivation, and most of the crops common to the region are grown. Yields are

low, however, and the soil can only be worked profitably under the best methods of soil management.*

BOONE FINE SAND

The surface soil of the Boone fine sand consists of a brown to yellowish-brown or grayish-brown fine to medium sand extending to an average depth of about 8 inches. This is underlain by a fine sand of a lighter yellow color than the surface, extending to a depth considerably below 3 feet. The amount of organic matter present is very low. There is some variation in the texture of both soil and subsoil and portions of the type might be classed as medium sand, but as the type is inextensive and as the fine sand seemed to predominate it was considered advisable to include all of the material in one type. In section 19 and vicinity in Manville Township the soil is slightly heavier than typical. A portion of it is also somewhat loamy, and as a result more productive than the typical soil.

The largest area of this soil, covering about 3½ or 4 square miles, occurs in Spring Creek Valley, in T. 24, R. 13. Most of the medium sand was found in this region. South of Mondovi and along the south side of the Buffalo River wind-blown areas occur. A few other patches of small extent are found associated with the Boone fine sandy loam in the northern part of the county.

The surface of this type varies from very gently undulating to gently rolling. There are a few low ridges and some low sand dunes, and where the type borders Rough stony land or other types occupying the steep slopes, the surface near the boundary frequently has considerable slope. On account of the surface features and the loose, open character of both soil and subsoil, the natural drainage is excessive and the type is droughty. None of the slopes is sufficiently steep to make the prevention of erosion an important factor in the management of this soil.

In origin the Boone fine sand is largely residual, having been derived from the weathering of Potsdam sandstone. There is but little organic matter present and such a small amount of silt and clay that the loose surface material is readily blown by the wind, and in a number of places low sand dunes have been

*For chemical composition and management see page 48.

formed. The material composing the type is in an acid condition, as indicated by the litmus-paper test.

The original timber growth on this type consisted chiefly of scattered scrubby oak. Coarse grasses and sand burs are also found growing on the type, though there are a number of places where the surface is bare of vegetation and the soil is now drifting.

On account of its loose, open character and the resulting droughty condition, its low content of organic matter, and the fact that it is subject to drifting in places, this soil has a low agricultural value. While most of it is cleared, there is a considerable proportion which is not farmed because of the small yields. Corn produces 20 bushels per acre where the rainfall is well distributed, but the crop if often a failure. Rye produces 8 to 12 bushels, and buckwheat 10 to 12 bushels an acre. Grass and clover are not successfully grown, and the coarse, wild grasses supply little pasturage. Potatoes are not grown extensively, and the yields are small. A portion of the type in section 19, Manville Township, is better than the average. Here corn frequently produces 30 bushels and buckwheat as much as 30 bushels an acre during favorable years.*

The selling price of most of the land of this type ranges from $10 to $15 an acre. The heavy phase, indicated above, has a somewhat higher value.

WAUKESHA GRAVELLY SANDY LOAM.

The type mapped as Waukesha gravelly sandy loam is of very small extent and of minor importance in the present survey. It occurs in two separate tracts which have a somewhat different texture. That just northwest of Cochrane has a surface soil which consists of 12 to 16 inches of black or dark-brown loam. This contains a considerable quantity of coarse, rounded sand particles, and in a number of places the surface soil is a sandy loam. There is usually sufficient clay present to make the soil sticky when wet. The subsoil consists of a yellowish sandy loam to about 24 to 30 inches, where rounded, rather fine gravel is encountered. This bed of stratified gravel and coarse sand is compact and difficult to penetrate with the soil auger.

*For chemical composition and management see page 48.

The second area is found on the terrace near Nelson. The texture of the soil here is somewhat more silty than that of the first mentioned area, though here also the soil varies to a coarse sandy loam, and in a few places a coarse loamy sand appears at the surface. This area is also underlain by stratified gravel. In a few localities this fine gravel outcrops, and there is considerable gravel scattered over the surface in such places. The surface soil is in an acid condition, as indicated by the litmus-paper test.

The surface of the type is level or very gently sloping. On account of the underlying sand and gravel beds the drainage is thorough, sometimes excessive, and, except where the covering over the gravel is deeper than usual, the type is inclined to be droughty during dry periods.

The type is a terrace soil situated well above the present flood plain. Portions of it appear to lie in an abandoned stream channel, later filled by sediment and now having the same elevation as the remainder of the terrace. In such places the gravel is as much as 4 feet below the surface.

The Waukesha gravelly sandy loam is a prairie soil, the native growth consisting chiefly of grasses.

At present the greater part of it is under cultivation, and during favorable years as much as 40 to 50 bushels of corn are grown per acre. Oats may yield 30 to 40 bushels and hay 1 ton to 1½ tons per acre. During dry seasons, however, the yields are considerably lower and crops frequently suffer greatly from lack of moisture.

PLAINFIELD FINE SAND

The surface soil of the Plainfield fine sand to an average depth of about 10 inches consists of a dark-gray to dark-brown fine sand having a loose structure and a comparatively low content of organic matter. Litmus-paper tests indicate that the soil is acid. The subsoil consists of a fine to medium sand, which becomes lighter in color and grades into stratified sand in the lower subsoil. There is some variation in the texture and some of the material included with this type could be classed as a medium sand if the areas were of sufficient extent.

The type is of small extent and of minor importance. The largest areas are found in Spring Creek and Little Bear Valleys.

The soil in Spring Creek Valley is somewhat coarser in texture than typical. In the vicinity of Waumandee there is also a small amount of this soil, and here the type is better than the average, having a finer texture and containing enough silt and clay to make it slightly loamy.

Generally the surface of the type is level or slopes gently toward the streams. In a few places there is a billowy topography, and small undulations are common. These are doubtless due to the action of the wind. On account of the loose, open structure of the material, the natural drainage is excessive. There are some portions of the type where erosion has cut rather deep channels, especially on the gently sloping terraces in Little Bear Valley.

Areas of this type occur within valleys of streams which head within the driftless region, and there is no glacial material, even in the stratified subsoil. The sand was doubtless derived from Potsdam sandstone and later carried down the slopes by the action of water and deposited by stream action when the volume of water was much greater than it is at present, and when the streams were running at a much higher level.

The original growth on the Plainfield fine sand consisted chiefly of a few scattering scrub oak and some prairie grass.

A relatively large proportion of this soil is under cultivation, but it is doubtful if the average crop is profitable under present conditions of farming. Corn is grown to some extent, but the yields are low. Probably the average is not over 15 bushels per acre. During dry years the crops usually fail. Rye, which is grown more extensively than other small grains, usually yields about 8 to 12 bushels per acre. Buckwheat yields 10 to 12 bushels per acre. Clover and the grasses do not thrive and the pasturage is of little value except early in the season. Potatoes are of fairly good quality, but yields are small. This type is low in organic matter, and in order that farming operations may be profitable the most careful methods of soil and farm management are necessary.*

Land of this type sells for $10 to $20 an acre. Farm buildings are usually inferior and fences and other improvements in poor condition.

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*For chemical composition and management of this soil see page 48.

PLAINFIELD SAND.

The surface soil of the Plainfield sand to an average depth of about 12 to 14 inches consists of a fairly loose, brown to dark-brown loamy sand of medium texture. There is a considerable amount of fine sand mixed with the medium sand in places, and in such places the soil might be classed as a fine sand if of sufficient extent. Litmus-paper tests indicate that the soil is acid. The subsoil consists of a lighter brown medium sand which gradually becomes a yellow sand at from 28 to 36 inches. The deep subsoil consists of stratified sand in which varying amounts of gravel may be found. As a rule the soil next to the bluffs is darker and slightly heavier than that close to the river.

The largest area of this type mapped in the present survey occurs as a narrow terrace along the Chippewa River Valley in the northwestern part of the county. This terrace ranges in width from one-eighth to one-half mile, and has a length of over 10 miles and an elevation above the flood plain of the river of 20 to 50 feet or more. The rise from the flood plain is quite abrupt in most places. At the mouth of Big Waumandee Creek there is a terrace of the same soil about 4 miles long and in its widest place about three-fourths of a mile across. None of this type is found outside of the Mississippi and Chippewa Valleys.

The terrace occupied by this soil has the same position as that occupied by the La Crosse fine sandy loam, and the surface is usually level or gently sloping toward the streams. In places there is an undulating or billowy topography, where the wind apparently has altered the original surface features to a slight extent. On account of the loose, open structure of the material the type is excessively drained and subject to drought.

Being of a terrace formation, the type is alluvial in origin, the material having been deposited by the Mississippi River during the glacial period, when the volume of water carried by that stream was much greater than at the present time. A small quantity of gravel is mixed with the sand in the lower sections, and this gravel is doubtless of glacial origin, as is also a part of the sandy material.

The greater proportion of this type was originally in the condition of a prairie, with only a few scattered scrubby oaks. Prairie grass was the most common growth, though this was not heavy.

More than half the area of the Plainfield sand is under cultivation, although as a whole it must be considered of rather low agricultural value. During the most favorable years, when the rainfall is well distributed, fair crops are obtained, but usually, owing to the lack of moisture and of plant food, the ordinary yields are not satisfactory. That part of the type immediately along the bluffs has probably been influenced to some extent by the wash from the heavier upland soils, and for a short distance from the bluffs yields are usually better than along the outer margin of the type. Some areas are uncultivated practically all of the time, because of their extremely sandy nature and consequent low productiveness. On some fields a crop is grown every second year and the ground fallowed in alternate years.

On this type rye is an important crop and yields of 20 to 25 bushels per acre are common during the most favorable years. Corn yields 25 to 40 bushels per acre under the most favorable conditions, but the ordinary yields are far below these figures. Buckwheat is grown to some extent. Clover can be grown successfully only on the lower, darker portions of the type, and even here the yields are not large. Potatoes do fairly well, but only a few are grown for market.

The selling price of land of this type ranges from $10 to $40 an acre, depending upon location, improvements, etc.

CHEMICAL COMPOSITION AND MANAGEMENT OF SANDS AND FINE SANDS.

On chemical composition these sandy soils show much less of the important plant food elements than do the upland silt loam soils of this county. The total phosphorus in the surface 8 inches averages 700 to 800 pounds per acre, while the amount of potassium is about 16,000 pounds in an acre inches. The organic matter in these soils is about half that in the Knox silt loam and less than one third of that in the dark prairie soils of the state.

Since Potsdam sandstone is the chief source of essentially all of these soils, they are low in lime carbonate, except in a few places where the sand occurs at a lower level than the beds of limestone, and thus receives a small amount of lime carbonate in the water from the higher slopes. The surface soil of all these types is acid, and will require lime. While these soils are defi-

cient in all of the important elements, they have certain advantages for special crops, and it is possible to profitably supplement their natural supply of plant food material by the use of fertilizers. All systems of farming on such land should be planned in such a way as either to conserve its natural fertility, or supply it by the use of commercial fertilizers.

The most important differences between these sandy types of soils and heavier classes, such as silt loams and clay loams, however, are not of a chemical nature, but of a physical nature, having to do with their water holding capacity, drainage, tillage, etc. Suggestions for the improvement of these types are based upon field experiments, chemical and mechanical analyses, and upon studies and observations covering a variety of sandy soils.

In the management of these sandy soils it should be kept in mind that they are naturally low in organic matter and in the mineral elements required, the water holding capacity is poor and the soil is acid. As all of the types in this group are in an acid condition they would be greatly benefited by the application of lime.

When the amount of organic matter or humus forming material in the soil is increased, the water holding capacity is also increased. The humus forming material can best be increased by applying stable manure and by plowing under legumes as green manure. Of the legumes red and mammoth clover are perhaps better adapted to sandy soils than any of the others, but neither of these nor alfalfa will make the most satisfactory growth until the acid condition is corrected. The mineral elements required may be supplied by the use of commercial fertilizers.

When a soil can be made to produce a fair crop of clover, without an excessive expenditure, that soil can be successfully and profitably improved. It is therefore important that the first efforts in building up a soil should be directed toward the establishing of conditions which will be favorable for the growth of clover.

From experiments conducted it seems advisable to sow clover without a nurse crop, where the fertility of the soil is very low, since it will then have all of the moisture in the sand for its own growth. There is also some danger of the young plants being damaged by the hot sun when the nurse crop is removed. The field intended for clover should be plowed in the fall, or as

early as possible in the spring, and a top dressing of ground limestone applied at the rate of 2,000 pounds per acre. The field should be harrowed at short intervals to kill all weeds, and this harrowing should be kept up until about the middle of May. Fifteen pounds of seed per acre should be sown and covered to a depth of 1½ to 2 inches. The seeding should be followed by a roller to compact the soil around the seed, and the roller should be followed by a light harrow to roughen and loosen the immediate surface to check evaporation and blowing of sand by the wind, or a corrugated roller can be used to do the work of both. Where it can be secured a top dressing of well rotted manure should be applied before the last harrowing. If manure is not available about 300 pounds of acid phosphate or ground steamed bone-meal and 100 pounds of muriate of potash should be applied at the time of seeding to clover. If only a small amount of manure is available it may be supplemented by ground rock phosphate, and this can be sprinkled over the manure in the spreader and applied at the same time.

Peat may often be used to advantage as a fertilizer if peat marshes are close at hand. It contains a high percentage of nitrogen, but should be supplemented by potash and phosphate fertilizers, as it is deficient in these elements. The use of a light application of manure will assist in making the nitrogen of the peat become available to plants.

Late in the summer it may be necessary to clip the weeds which are sure to come. The cutting bar should be run high and the clipping left on the field as a mulch. The second year the first crop should be cut for hay and the second crop plowed under as green manure to prepare the land for a cultivated crop. After the first application, ground limestone should be applied at the rate of about 1,000 pounds per acre once during every rotation. The amount of commercial fertilizers containing phosphorus and potash which should be subsequently applied will depend on the crops to be grown and especially on the amount of manure produced on the farm.

Soybeans or yellow lupine or spring vetch may be grown on sandy soils and if plowed under they furnish organic matter and nitrogen to the soil. When the soil has been built up, a nurse crop may be used in seeding clover and other legumes to better advantage than when the soil is run down and poor.

A three, four, or five year rotation may be followed. If but little stock is kept, a three year rotation consisting of a cultivated crop of corn or potatoes followed by rye or oats and clover the third year works well. The second crop of clover should be plowed under. If manure is scarce, acid phosphate and potash must be applied in addition to green manuring crops to keep up the fertility of sandy soils. If considerable stock is kept the rotation can be increased to four years using the clover field one year for pasture before plowing up. The manure applied in the winter or early spring of the year the clover is pastured increases the value of the pasture and benefits the next crop. The silo should be used to supplement pasture on sandy soil.

In a five year rotation alfalfa may be introduced, but this requires that considerable stock be kept, since none of the alfalfa should be sold. The field should be left in alfalfa for three years with two years given to cultivated crops and grain. Manure should be applied to the cultivated crop and also to the first year of alfalfa. This system is very desirable except that it does not provide any pasture. To overcome this the farm may be divided and both the four and the five year rotation practiced. Alfalfa may also be grown by itself and kept on the same field year after year, in which case its place in the rotation should be filled by clover. When the alfalfa begins to run out, the field should be reseeded.

In the cultivation of the sandy soils fall plowing for rye, and spring plowing for all other crops, is the usual practice. The seed bed should be prepared to a depth of at least 8 inches and organic matter should be worked in deeply as well as near the surface to increase the water-holding capacity and to induce a deeper development of the roots. When the land is plowed in the spring it is often advisable to pack the soil with a roller, but this should be followed by a light harrow to secure a mulch on the surface. Where the fields are exposed, and the soil is blown by the wind, an effort should be made to prevent damage from this source. The most effective plan is to lay out the land in long narrow fields so as to have crops that cover the ground in the early spring, such as clover and rye, alternate with the cultivated ground.

With the successful growing of clover and possibly alfalfa, the dairy industry may be developed to a much greater extent than at present. By plowing under a crop of clover every few

years and by following a definite rotation and approved methods, the yields of potatoes will be greatly increased; and this crop may well be depended upon as one of the chief sources of income for the sandy soils of the area. Beans, peas, sweet corn, etc., could be profitably grown to a much greater extent, and the trucking industry should be extended where arrangements can be made for marketing. The soil warms up early and is well suited to cucumbers, strawberries, and all quick maturing vegetables.

CHAPTER VI.

MISCELLANEOUS MATERIAL.

ROUGH STONY LAND.

Rough stony land includes rock exposures, cliffs, and land which is too steep and rough to plow or cultivate profitably. It may be considered nonagricultural, as it is of value only for the small amount of timber and pasture which it supplies.

This type occupies a large part of the steep walls bordering the valleys and forms a border between the valley bottoms and the high land of the ridges. The type is developed as narrow bands, many miles in extent, winding in and out of the valleys and coves, but confined to the steepest slopes. A part of the type occurs as narrow ridges upon which areas of soil too small to be mapped are sometimes found. The bluffs and cliffs are highest along the western portion of the county, and frequently reach an elevation of 450 to 500 feet above the valley bottoms there. The ridge tops are also wider here than elsewhere, and range in width from one-half to 1 mile, while in the interior of the county and along the eastern portion the valleys ramify more extensively, the ridge tops are narrower, and the steep valley walls are not so high. The elevation of the ridge tops ranges from 150 to 250 feet above the valley floor throughout most of the interior of the county.

Rough stony land is quite uniformly distributed throughout the upland portion of the county and is intimately associated with Knox silt loam and the steep phase of that type. Wherever there are a few inches of soil it is usually a silt loam, though there are exceptions to this in the region of sandstone rocks where the soil is sandy. The greater proportion of the rock exposed consists of lower Magnesian limestone, though there is also considerable Potsdam sandstone exposed directly below the limestone.

The forest growth consists of white oak, red oak, hickory, and a few birch and elm trees. The best of the timber has been removed and the remainder serves to protect the slopes from washing.

The inclusion of Rough stony land in farms reduces the value of better land and it renders the fields and farms on the ridges less accessible. It makes hauling to market difficult, as many of the roads from the valleys to the upland cross steep strips of this class of land.

THE GENESEE SOILS.

This series of soils includes all material deposited in the present flood plains of the Mississippi and Chippewa Rivers which border the county on the west and north, and of the lower part of Buffalo River in the center of the county. Owing to the mixed nature of the material and difficulty in seeing much of it, the separation of types on the floodplains is not done in a strictly detailed manner, the main object being to separate the sandy soils from the heavier ones.

GENESEE FINE SANDY LOAM

This type includes all the sandy material of the floodplains above mentioned. Much of the soil which is a fine sandy loam consists of 6 to 10 inches of compact dark brown fine sandy loam on yellowish brown fine sandy loam or fine sand. Layers of medium or coarse sand often occur in the subsoil at varying depths. Considerable variations in the texture of this type occur. Chocolate brown fine sandy loam or loam soil often borders the banks of the sloughs or sand knolls and ridges occur with intervening swales and low spots of heavier loam or silt loam soil on sand. This type of soil follows the channels of the Chippewa and Mississippi Rivers and the sloughs connected with them all along the north and west sides of the county, occupying a considerable portion of the 32,000 acres of flood plain land in the county. Some of thte islands in the Mississippi River are mere banks or flats of sand built up by the river, others are sandy around the edges with heavier soil in the interior. Considerable amounts of the more sandy phase are included also

in Sections 12, 13, 24, and 25 east and north of Maxwell Station.

The Genesee soils lie upon a low level to flat irregularly wooded plain cut by sloughs and old stream channels. Some of the sandy knolls are more elevated, the type lying from 1 to 10 feet above normal water stage. Some of the higher sandy knolls are seldom if ever flooded but most of the bottom land is subject to flooding especially in spring. Occasionally as much as 6 or 8 feet of water has covered the bottoms. Floods are less frequent since the discontinuance of logging operations and dams on the sloughs. In general the highest elevations occur along sloughs and along the rivers.

The soil material has been deposited in the valley bottoms by the more recent floods of the rivers and is largely derived from glacial material brought down by the streams from farther north and east.

In the lower portions and bordering the sloughs the soil is timbered, often quite heavily, to elm, oak, birch, and soft maple or birch and willow brush. More elevated or sandy portions subject to considerable drying out at times, have scattered oak and in some cases a semi-prairie condition with red-top grass and scattered oaks, is found.

Some small patches of the soil have been under cultivation and very good yields obtained. Most of the soil cannot be used and serves only as a pasture land and furnishes some hay. The higher sandy portions which are cultivated in one or two places, produce good rye, potatoes, or corn, but in dry seasons are subject to drought due to the open sandy subsoil which prevents capillary rise of water. Less elevated portions of the soil which are also somewhat finer are reported to have produced as much as 60 bushels of corn, 250 bushels of potatoes, and 60 bushels of oats per acre in favorable seasons. These yields cannot be depended upon because these lower portions of the soil type are often subject to overflow.

Low Phase Genesee Fine Sandy Loam.—Within the area of fine sandy loam (largely wooded) are included low open areas of overflow land which are covered with water most of the time. The vegetation consists of reeds, sweet flag, and generally coarser marsh grasses. Where such areas are extensive they have been separated out as low phase of the fine sandy loam.

The soil on such overflow areas is generally heavier than that on the wooded portions and varies greatly in depth and texture.

The soil is generally a grayish drab or mottled brown loam on a sandy loam subsoil. The surface heavy layer is often only 2 to 8 inches deep, but may be as much as 3 feet deep in the larger open areas. Coarse sand layers may be found in the subsoil in shallow places and bluish sticky clay layers are also found where the soil is deeper. In Section 1 southwest of Nelson, the soil of this phase is a mealy chocolate-brown loamy material containing much organic matter, fine silt, and coarse sand grains. This is 6 to 10 inches deep on dark brown sandy loam.

None of this phase of the soil has ever been cultivated and it now has little agricultural use, the amount of hay cut on it being limited because of the generally coarse nature of the grasses which grow on most of these low areas.

GENESEE SILT LOAM.

This is a compact mealy chocolate-brown silt loam becoming lighter brown in color at 8 to 12 inches. Fine and very fine sand particles are found in the subsoil in increasing amounts until at about 16 to 20 inches the soil often becomes a fine sandy loam with yellowish brown sandy loam at 20 to 30 inches. The depth of surface soil varies from 8 to 30 inches. In low wet marshy places the soil is a grayish or bluish mottled color with a sticky clay loam subsoil underlaid at greater depth by sandy loam material.

This type covers about 17 square miles of the bottom lands from Alma north along the Mississippi and Chippewa Rivers.

The surface is level with some small knolls and is cut by old sloughs and drainage courses or slightly lower marshy areas. The elevations are greatest near the larger streams and the best drained areas border the Chippewa and Mississippi Rivers.

Like the other Genesee types the soil was deposited by overflow waters of the rivers and is still subject to overflow in time of high water.

The vegetation consists of heavy timber composed largely of big trees. Elm, soft maple, oak, and cotton wood are interspersed with more open glades covered with a dense growth of tall blue joint grass. Lower more continually flooded marshy areas are covered with coarser grasses, reeds, and sweet flags as well as patches of brush-alder, willow, and birch.

Outside of pasture land and the cutting of blue joint hay, very little agricultural use is made of the soil at present. Farms have been started at a number of places, but the almost annual flooding and uncertainty of crop yields has led to their partial or complete abandonment in most cases. The soil material is highly fertile and in favorable seasons excellent yields of corn, small grain, potatoes, and tame hay have been produced. Drainage would require expensive dikes or levees to keep off floods, but if its drainage could be accomplished this soil would make excellent farm land.

GENESEE SILTY CLAY LOAM

This is a dark brown sticky silty clay loam on medium to fine sandy loam. The depth of heavy surface soil varies from 8 to 30 inches or more. The deepest dark brown surface layer occurs on the higher portions near the streams. Grayish or mottled brown silty clay loam with blue clay subsoil at 18 to 24 inches is found in the lower open marshy areas near the main land. As with the other Genesee types, this soil type is not entirely uniform and includes some soil of lighter texture. A sticky brown or mottled loam or sandy loam on a sandy loam subsoil occurs in places, especially along the immediate banks of the sloughs.

The silty clay loam covers about 8 square miles of the bottoms from Fountain City south to Marshland.

The topography is level with slight knolls or slightly elevated areas interspersed with lower wet areas. In dry years with low water, some of the more elevated portions have sufficient drainage for cultivation. The lower marshy portions and all of the type in times of high water is too wet to cultivate and drainage by diking ditches and probably pumping are necessary to make the land available for continued farming.

The soil is an alluvial deposit laid down in more quiet water than that in which the coarser soils to the north were deposited.

As in the case of the silt loam, the soil is partly timbered with large elm, oak, soft maple, basswood, and birch trees. Tall blue joint grass grows among the more scattered trees. Much of the soil is in a marshy condition and coarse grasses and sweet flags cover these portions with scattered clumps of birch and willow tree brush.

In the southwest corner of the county a part of this type of soil has been protected from overflow and partially drained by straightening the channel of the Trempealeau River by closing some of the sloughs and dredging a main ditch through the area. Crops consist mainly of corn, hay, and some potatoes. Only the higher knolls are cultivated, hay being cut on the lower portions. The soil is fertile material and when well drained produces very good yields.

WABASH LOAM.

The Wabash loam where typically developed consists of a black loam surface soil extending to a depth of 12 to 16 inches, underlain by drab or grayish loam or silt loam which, in the lower subsoil, grades into sandy material. As found in this county, however, the type is quite variable and there is a considerable proportion which does not conform closely with this description. In a number of places the surface soil contains varying quantities of fine and very fine sand, and in such places the color is usually lighter than where the texture is a loam or silt loam. In a number of places the subsoil is darker than the present surface soil, owing to the fact that the original black surface has been covered by wash of lighter colored material from the adjoining slopes. Frequently large amounts of sand and fragments of limestone have been washed out over the soil from the tributary valleys and ravines and the variations which result from such conditions could not be indicated. The material composing the type, however, is better adapted to agricultural development than most of the Genessee Series and was therefore separated from that series.

The Wabash loam is found most extensively along the Buffalo and Trempealeau Rivers and Big and Little Waumandee Creeks and some of their tributaries. It occupies narrow strips along these streams and is the lowest land in the bottoms. The surface usually has a gentle slope toward the streams and most of the type is subject to overflow. By straightening and deepening stream channels much of this type doubtless could be reclaimed. Tile drains could also be used in draining such tracts.

In origin this type is largely alluvial, though there are many narrow valleys and ravines having a small amount of this soil

VIEW ACROSS THE VALLEY OF THE BUFFALO RIVER.

The wooded portion of the valley is the flood plain where Wabash soils occur. On the terrace Lintonia silt loam is found, while on the rolling background Knox silt loam is the most extensive soil.

along the bottoms where the material is colluvial in origin. In such places there is a great rush of water during heavy rains, but this quickly runs off on account of the steep grade.

The growth on this soil consists of willow, hazel brush, poplar, cherry, elm, and soft maple. There is a rank growth of grass over much of the type, affording excellent pasturage, and frequently hay is cut where there is no brush to interfere.

The cutting of hay and pasturing are the only agricultural uses to which the Wabash loam is put at present. If properly drained, as some of it could be, it would be adapted to corn, small grains, timothy hay, alsike clover, and a number of other crops.

PEAT.

Description.—The material mapped as Peat consists of vegetable matter in various stages of decomposition and with which there has frequently been incorporated a very small quantity of mineral matter. The surface is black or dark brown and is usually fairly well decomposed, while the underlying material is of a brownish color and fibrous in most cases. The Peat extends to a depth greater than 3 feet in all cases, and it is probable that it exceeds 10 feet over most of the areas, though the exact depth was not determined.

Extent and Distribution.—The Peat in this survey is of rather small extent. The largest area extends from about 3 miles west of Mondovi west and northwest to the county line and southward through several stream valleys. The area comprises the divide between Farrington Creek, flowing east into Buffalo River, and Big Bear Creek, flowing west into the Chippewa River. This divide, however, is not marked, and no differences in elevation in the marsh can be detected by the eye. Other areas of Peat are encountered in various stream valleys throughout the county, the largest occurring along the Trempealeau River in the southeastern part of the county. These consist of low, wet tracts bordering the river, and it would be difficult to reclaim them.

Native Vegetation.—Some of the areas of Peat are timbered with a dense growth of tamarack, while other portions are treeless and support a thick growth of coarse, wild grass. In Farrington Creek Valley both conditions are found. Over the open marshes

the wild grass is frequently cut for hay, and this is the extent of the present agricultural use of this soil.

In a number of the Peat areas reclamation is practicable. When properly handled the Peat should yield good crops of corn, timothy, and alsike clover, and even small grains can be grown successfully.

None of the Peat soil has been artificially drained, its agricultural use being confined to pasture and production of hay.

Chemical Composition and improvement of Genesee soils and Peat.

CHAPTER VII.

GENERAL AGRICULTURE OF BUFFALO COUNTY.

Agriculture in Buffalo County dates back to the first settlements of this region, which were made between 1845 and 1850. As was the case in other parts of Wisconsin, the production of grain early became the chief branch of farming, and for a considerable time wheat was grown more extensively than all other grains combined. As late as 1885 wheat still constituted about 50 per cent of the grain produced, while oats made up about 27 per cent and corn about 16 per cent. The history of grain growing in this region is similar to that of other parts of the State. Fields were cropped to grain continuously for such a long period that the productiveness of the soil was gradually reduced, and when the prices began to decline and insect pests became troublesome the crop was not very profitable. During the last 25 or 30 years there has been a gradual falling off in the production of wheat, and in 1910 the total acreage for the county was only 4,575 acres. With the decline in wheat growing there has been an increase in the production of oats, hay, and corn, and the system of farming which is followed at present is a much better one than that practiced a half century ago.

The present agriculture consists of general farming, with dairying as the most important and highly specialized branch, and the tendency throughout the county is toward a still greater development of the dairy farming. With this industry are coming better methods of farming, improved grades of live stock, and a greater interest in all lines of agricultural development.

The general farm crops most extensively grown, in the order of their acreage, are oats, hay, corn, barley, rye, and wheat.

Oats are grown more extensively than any other crop in the county, and in 1909, according to the census reports, 1,377,555

bushels were produced from 46,304 acres, or about 30 bushels to the acre. Part of the crop is marketed through elevators at Fountain City, Alma, Mondovi, and Winona, Minn., but the greater part is fed to stock on the farms. Oats form the bulk of the grain fed to horses and are ground as part of the ration for feeding cattle and hogs. The crop is grown mainly on the Knox silt loam. It is grown quite extensively also on the Lintonia silt loam, Boone fine sandy loam, Bates silt loam, and Waukesha silt loam, on all of which good yields are obtained. On the more sandy types yields are considerably lower. The quality of all small grains is best where grown on light-colored soils, and the Knox silt loam is considered to be the best small-grain soil in the county. On dark soils the growth of straw is apt to be too rank and the plants frequently lodge. Also, the grain is slightly inferior in quality, and is lighter in weight than that grown on the lighter-colored silt loam types.

Hay is the second crop in importance. In 1909 hay was cut from 40,709 acres, producing 75,059 tons, or an average of about 1¾ tons per acre. Clover and timothy constitute the greater part of the hay grown. There is a considerably greater acreage devoted to timothy alone than to clover alone. Much wild hay is cut from areas of Peat and Genessee Soils and some from wet areas of Wabash loam. There are a few fields of alfalfa in the county, but this crop is grown only to a very small extent at present.

Corn ranks third in acreage. From 25,043 acres in 1909 a yield of 838,441 bushels was obtained, or an average of over 33 bushels per acre. The Waukesha and Bates silt loams are the best corn soils in the county and on these types yields of 50 to 60 or even 70 bushels per acre are obtained under favorable conditions, and the average yield is always considerably above the average for the county. A large quantity of corn is cut and put into the silo each year, and the quantity is gradually increasing as the dairy industry develops. Practically all of the corn allowed to mature is fed to hogs or other stock on the farms where it is produced, and comparatively little is sold. Dent varieties are grown most extensively, and improvement is being made through the use of more carefully selected seed.

Barley ranks fourth in acreage, 24,911 acres in 1909 giving 632,422 bushels, or an average yield of slightly over 25 bushels per acre. Barley is grown on most of the soils of the county, except the extremely sandy types. It appears to do better than oats on sandy and fine sandy loam soils. The acreage on the Knox silt loam has been decreasing more rapidly than on some of the other types, probably because of the growth of the dairy industry on this type. As in the case of oats, grain of the best quality is produced on light-colored soils.

Rye is one of the most important crops on the light-textured soils of the county, though it is grown to some extent on practically all of the cultivated types. The acreage in 1909 was 4,663 acres and the production 67,511 bushels, or slightly over 14 bushels per acre. This crop is better adapted to sandy soils than the other grains grown in the county.

In 1909 wheat was grown on 4,575 acres, with a production of 88,302 bushels, or about 19 bushels per acre. The crop is grown mainly on the Knox, Lintonia, and Bates silt loams. Some of the fine sandy loams also are used for the production of wheat. The Knox silt loam produces a very good quality of wheat, as well as of other small grains.

Potatoes are not grown on a commercial scale, except in a few instances. The potato patch seldom covers more than an acre or two. According to the census, 1,423 acres were devoted to the crop in 1909, producing 177,849 bushels, or about 125 bushels per acre. During favorable seasons yields of 250 bushels an acre are obtained from fields which have received special attention.

In the vicinity of Alma and Fountain City small fruits and grapes are grown successfully, and the trucking industry has been developed to a small extent. In the southern part of the county about Marshall and also in the northeastern part about Mondovi there is a little trucking carried on, and it would seem that this industry might be profitably extended. Peas and beans are not extensively grown, but cucumbers, chiefly for pickling, are grown in various parts of the county, Alma and Fountain City having pickling stations. Raspberries, currants, strawberries, etc., do very well. Many farmers have small apple orchards from which fruit of good quality is usually obtained, but apples

are not grown on a commercial scale. There are a large number of excellent orchard sites throughout the county, the climatic conditions are favorable, and it would seem that apple growing might well be developed on a commercial scale.

In 1913 there were 17 cheese factories and 10 creameries in Buffalo County, and the output of dairy products is gradually increasing. Dairying is carried on in all parts of the county, but is most highly developed on the silt loam and fine sandy loam soils. Considering the county as a whole, dairying is probably better adapted to the Knox silt loam than to any other type. This type is excellent grain, grass, and clover soil, fair corn soil, and has associated with it a large amount of steep land and Rough stony land which provides an abundance of excellent pasturage.

Most of the dairy herds in the county are made up of grade animals, with occasional herds of pure-bred Holstein, Guernsey, and Jersey. The use of purebred sires is gradually bringing the dairy stock of the county to a higher standard. Beef cattle are raised to some extent. Among the pure beef breeds the Shorthorn and Aberdeen Angus are represented most largely. There is some Hereford blood in the county also, and the number of all purebred animals is gradually increasing, though most of the beef cattle are grade stock. A considerable number of calves and young stock are shipped out of the county each year.

On the dark, level soils of the valleys corn is grown more extensively than in the upland regions, and therefore in these sections hog raising is carried on to a greater extent than elsewhere, though some hogs are raised in all parts of the county in connection with dairying. More hogs and other stock are raised in the Waumandee Valley and in the vicinity of Mondovi than in other portions of the county.

There are more horses raised in Buffalo County than in any other section of the State, and purebred Percheron, Morgan, Clydesdale, and Belgian horses are to be seen throughout the county. Most farmers raise their own work stock, and many plan to have a heavy draft team to sell every few years. There are a few farmers who make a business of raising horses.

Sheep raising is carried on to some extent, and there are a number of farmers raising purebred sheep in various parts of the county.

The adaptation of soils to crops is recognized to some extent.

The dark Waukesha and Bates soils are known to be better corn soils than the lighter colored types, and the Knox silt loam is held better adapted to small grains than are the dark soils. Rye and buckwheat are confined principally to the sandy types of soil, because experience has shown that these soils can be used profitably for this crop.

While crop rotations vary on the different soils throughout the county, probably the most common rotation consists of corn followed by a small grain, such as oats, barley, rye, or wheat one year, or possibly two years, and then seeded to timothy and clover. Hay is usually cut for two years. Very often the hay field is not pastured, since there is a large area of rough land on most farms which is devoted largely to grazing. On the sandy soils the ordinary rotation is somewhat different, and may consist of one year corn, followed by one year rye seeded to clover, followed by corn. On some farms but little thought is given to the selection of crop rotations best suited to the conditions, but more attention is each year being given to such matters, with the result that farm methods are gradually improving and yields increasing.

Stable manure is about the only fertilizer generally used at present within the county. Some green manuring is practiced, but it is not at all common, and commercial fertilizers are seldom used, except in a small way for special purposes. The methods of cultivation followed by the majority of the farmers are thorough, and agriculture is highly developed in nearly all parts of the county. The Waumandee Valley is considered to be one of the richest sections of the county, chiefly because of the rather extensive areas of level, black silt loam which are to be found there. On the Bates silt loam and fine sandy loam, as well as on the Knox and Lintonia silt loams, very fine farms are to be found. Special methods of cultivation are frequently required in this county, because of the danger of erosion on the steep hillsides. These special methods of hillside cultivation are covered under the discussion of the various soil types to which they refer.

Of the weed pests which are found in Buffalo County the Canada thistle and quack grass are probably the most troublesome.

Farm improvements vary with the character of the soil, but

as by far the greater proportion of the soil in the county is productive most of the farms are well improved, and the buildings are substantial and kept in good repair. The best farms and buildings are found on the Knox, Waukesha, and Lintonia silt loams, and on the Bates silt loam and fine sandy loam. On the extremely sandy soils the poor quality of the soil is réflected in the buildings, fences, crops, and farm machinery.

Obtaining farm labor is sometimes difficult, and on account of this condition the systems of agriculture followed are often more extensive than would otherwise be the case. In many instances all of the work is done by the farmer and his family. When a man is hired for the entire year the monthly wage is about $25 to $30.00 with board and washing free. When employed only for the summer or the growing season or for haying and harvesting the wage is higher. When married men are employed, a house, fuel, and garden patch are often supplied in addition to the regular wage.

According to the census of 1910, 92.8 per cent of the land in Buffalo County is in farms, and of this 49 per cent is classed as improved. The average size of farms is given as 189 acres and the average amount of improved land on each farm is 92 acres. Eighty-one per cent of the farms are operated by their owners, and considerably over half of these are free from mortgage debt. In most cases where land is rented, cash rather than share payments, are made.

During the period from 1900 to 1910 the value of lands in Buffalo County increased 67.7 per cent. Values vary greatly, depending upon the soil, location, improvement, etc. The best farms in the county have a selling value of $100 to $150 an acre. The poorest farms, on the extremely sandy soils, could probably be bought for $10 to $15 an acre. Farms on the Waukesha silt loam, Bates silt loam, Bates fine sandy loam, Knox silt loam, and Lintonia silt loam have a higher value than those on other types. These are recognized as the best soils of the county. The Knox silt loam is the most extensive type but some of the others mentioned, while of small area, are highly improved. In Waumandee Valley, for example, farms on the Waukesha silt loam are as highly developed as, or possibly more highly developed than,

those in any other section, and Waumandee Valley is considered one of the richest agricultural sections of the county.

In general, it may be said that the methods of farming and agricultural practices followed in the county are fairly well adapted to the existing conditions.

CHAPTER VIII.

THE PROBLEM OF EROSION IN BUFFALO COUNTY.

The most important single problem in soil management in Buffalo County is due to the large amounts of steep or rolling land. The county is in the so-called residual portion of the state where the streams which drain the area have cut down their beds through the formerly level elevated plain lying on limestone and into the sandstone beneath. These valleys have never been altered or filled by action of glaciers which once covered most of the state. The valleys were at first mere erosion ditches or small stream beds which have been enlarged and deepened during geological ages till their beds lie from 200 to over 400 feet below the limestone topped ridges which extend between. The valleys and their tributaries radiate like the veins of a leaf and the steep slopes which lead down from the ridge top to valley bottom make up a considerable part of the area of the county.

Most of the soil on the sloping land is heavy and is included in the steep phase of the Knox silt loam. These slopes which originally were timbered or brush-covered have been largely cleared and cultivated. Because of their unprotected condition and exposure to the work of surface run-off water from higher land, fields on this type of soil are often extensively washed and gullied by the descending storm water and the water from melting snow in spring.

Other soils subject to erosion are the soils of the Boone series derived from sandstone and which often occupy lower slopes in the valleys. The soils of the Lintonia series which lie in narrow benches along the sides of the valley bottoms are also subject to severe gullying. The swift flowing water from the ridges and slopes must cross these benches before reaching the valley stream and deep ravines, gullies, and ditches are developed. Soil erosion is a farm problem not only because fields are cut by ditches and gullies which make cultivation difficult, but because erosion removes the finest and most fertile soil particles first and reduces

VIEW SHOWING HOW RAVINES MAY BE STARTED ON A GENTLE SLOPE WHERE THE SURFACE IS NOT PROTECTED BY A GROWING CROP.

Much of the land in Buffalo County is subject to erosion and care should be exercised in cultivation and in rotations followed on the steep land so as to reduce the amount of damage by washing to the minimum.

the fertility and yield of fields by removing fine soil and organic matter from the surface. The causes of removal of soil from the surface without formation of gullies generally lie in improper methods of cultivation or poor arrangement of fields. Fields where this kind of erosion occurs are often only gently rolling or undulating and the rain water does not collect in larger swift-flowing rills or streams which have power to cut ditches, but follows the cultivated rows such as corn or potatoes or the drill rows of grain fields and the soil is removed only from the knolls and deposited in the hollows.

Contour cultivation and arrangement of the crop rows across the slope instead of with or down the slopes retards the movement of soil in such fields. Keeping the most exposed places in sod as much as possible and the cultivation of the field in alternate strips of crop and sod across the slopes are inconvenient but often necessary methods.

Rotation of crops in such a way that two cultivated crops do not follow in succession gives the field opportunity to recover from its losses under cultivation and avoiding a hard bare condition of the eroded ground after harvest as much as possible prevents surface wash in the fall. A cover or catch crop of rye or peas in the corn rows helps protect the soil after harvest and furnishes pasture until winter.

Deep plowing and plowing under of straw, manure, or a second crop of clover to increase the organic matter in the soil also give the surface of the field greater absorbing capacity and resistance to erosion.

Gullying occurs where greater volumes of water collect forming cutting-streams where steeper slopes cause the water to flow faster or in places where the soil has an unstaple foundation of sandy material which easily undermines when the water once cuts through the surface soil and establishes a fall which cuts back in the sandy subsoil. In favorable situations large gullies ½ mile or more in length are sometimes cut during a single season.

In their beginnings most small gullies are easily handled. Small drainage-ways or shallow ditches can be filled with straw or manure and plowed shut. Such shallow drainage-ways should be left in permanent sod. The plow can be easily thrown out in passing across them. On the level terraces or where heavy soil lies on light sand or sandy gravelly subsoil, small ditches must

be immediately tended to because all ditches on such soil are dangerous.

Where the subsoil is clay and where clay or silt soil material is being brought down by the flood water, large gullies may be made to fill by putting in a dam of stumps, brush, and logs. Where the subsoil is sandy much greater care is required. If dams are built in the latter case, they need to be carefully constructed to prevent the water from cutting around them.

Dams of concrete, stone, wire mesh, and brush have been successfully used. Flume devices also have been used to carry the water over the head of the ditch and down into it preventing its continued growth.

Planting willows and bushes on the sides and bottom of ditches too deep to fill often arrests the growth of the ditch. Sorghum, sweet clover, or rye make good emergency crops on eroded spots and fields which later need to be seeded to grasses and left in permanent sod.*

*See Bulletin 272 of the Wisconsin Experiment Station.

CHAPTER IX.

CLIMATE*

"Among the factors which influence the agriculture of a state none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season, and the amount and distribution of the rainfall." Any one of these factors may determine the type of farming which can be followed to best advantage.

"The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of from 28 to 34 inches, while the mean for the state as a whole is 31 inches. This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany, Sweden, and the Dundee Valley. As compared with other portions of this country, Wisconsin has a total rainfall equaling that of central Oklahoma and Kansas, northern Iowa, Michigan, Northwestern New York, or the Puget Sound Basin of Washington. But owing to its northerly location, the lessened evaporation probably makes the precipitation as effective as that of Arkansas, Illinois, or Virginia."

The local distribution of rainfall varies, however, from year to year, some sections receiving more rain one year, and other sections more in other years. The variation is caused largely by the movement of cyclonic storms. The average rainfall for the entire state during the driest year was 21.4 inches, and for the wettest year 37 inches.

"Of equal importance, in agriculture, to the total rainfall, is its seasonal distribution, and in this respect Wisconsin is unusually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70% from April to

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*This chapter has been taken largely from Wisconsin Bulletin 223 on The Climate of Wisconsin and its Relation to Agriculture. This bulletin should be consulted if more information is desired concerning climate. All quotations indicated are taken from this bulletin.

September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand is slight; December, January, and February each averaging from 1 to 1.5 inches of rain and melted snow. The average rainfall for the state during the winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches and during autumn 7.4 inches. Most of the rainfall occurs just preceding and during the period of plant growth, thus being received by the crop at the most effective time. Wisconsin receives during the growing season, April to September, inclusive, an average of 21 inches, which is as much rain as is received during the same months by eastern Texas, Illinois, Ohio, or eastern New York. The small winter precipitation in Wisconsin, mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil, or erosion.

Another phase of rainfall distribution of great importance is its variation within a period of a few weeks. Frequently periods of drought and periods of unusually heavy rainfall occur, continuing for from one to four weeks, and occasionally longer. Observations taken at Madison over a period of 30 years, from 1882–1911, inclusive, show that there are, on the average, three ten day periods during each growing season when the amount of rainfall is so slight that crops on a reasonably heavy soil (Miami silt loam) actually suffer from the lack of moisture.

Buffalo County lies partly within the Mississippi Valley and partly within the Southern Highlands, which are recognized as forming two of the eight climatic provinces in Wisconsin. The Mississippi Valley is a rather deep depression, the warm influence of the lower altitude being apparent from Dubuque, Iowa, as far north as Grantsburg, Wis. This narrow valley is much cooler and has drier winters than the Lake Michigan shore. The mean summer temperature averages about 78° F., and is similar to that of New Jersey, southeastern Pennsylvania, Ohio, or southern California. The mean winter temperature in the northern part of this valley resembles that of northern Vermont, northern Michigan, or eastern Montana. On an average of seven days during the winter the thermometer drops to –10° F. or lower, while during summer afternoons a temperature of 95° may be expected. The growing season in this valley ranges from 150 to 175 days, about the same duration as that of the Hudson

River Valley, nearly all of Ohio, the northern half of Illinois, western Kansas, or the Columbia River Valley.

The Southern Highlands includes the rough and rolling region, generally over 1,000 feet in elevation, extending from Clark County south to the Illinois line, and lying between the Mississippi Valley on the west and the Wisconsin and Rock River Valleys on the east. It is characterized by a cooler temperature than the adjoining valleys, the summer temperature (66° to 29° F.) being similar to that along the Michigan shore, while the mean winter temperature is only 2° higher than along the Superior shore. The growing season, averaging 145 days, is apparently 20 to 30 days shorter than on the lower lands of the State in the same latitude, while in the river valleys and ravines in this section the frost danger is still greater.

The first of the following tables gives the mean monthly and annual temperature and precipitation at Wabasha, Minn., and at Whitehall, Wis. Wabasha is situated just across the Mississippi River from Buffalo County, and Whitehall is located in Trempealeau County, which borders Buffalo County on the east.

The station at Wabasha has an elevation of 681 feet above sea level and the station at Whitehall is 675 feet above sea level, so that these records indicate the weather conditions of the Mississippi Valley and the Trempealeau River Valley rather than of the whole region surveyed. The greater part of the county is from 200 to 400 feet higher than the river valleys, and varies somewhat in the length of growing season, as indicated above.

The second table gives the normal monthly, seasonal, and annual temperature and precipitation and the average dates of first and last killing frosts at Eau Claire, about 14 miles north of the north county line. This station has an elevation of 800 feet. A comparison with the tables from the other points mentioned may be of interest.

NORMAL MONTHLY AND ANNUAL TEMPERATURE AND PRECIPITATION AT WABASHA, MINN., AND WHITEHALL, WIS.

Month	Wabasha, Minn., 14 years		Whitehall, Wis., 17 years	
	Temperature	Precipitation	Temperature	Precipitation
	°F.	Inches	°F.	Inches
December	20.2	1.19	18.8	1.34
January	14.4	.99	14.1	.84
February	16.7	.95	14.2	.96
March	30.5	1.77	30.5	1.58
April	47.5	2.52	46.2	2.41
May	59.3	4.23	57.0	4.06
June	67.8	4.12	66.2	4.30
July	12.3	3.54	70.2	3.45
August	70.0	3.43	68.3	3.63
Septemb r	62.4	3.56	61.6	3.80
October	49.7	2.84	49.2	2.46
November	33.1	1.56	33.9	1.39
Annual	45.3	30.68	44.2	30.22

NORMAL MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE PRECIPITATION AT EAU CLAIRE, EAU CLAIRE COUNTY

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year	Total amount for the wettest year
	°F.	°F.	°F.	Inches	Inches	Inches
December	18.7	54	—28	1.48	0.27	0.84
January	13.1	54	—34	1.00	0.32	0.32
February	14.3	59	—40	1.28	2.26	0.87
Winter	15.4	....	....	3.76	2.85	2.03
March	8.7	75	—18	2.04	2.85	2.10
April	45.6	88	11	2.58	2.22	3.72
May	57.0	94	20	4.37	1.96	7.03
Spring	43.8	....	....	8.99	7.03	12.85
June	66.8	97	25	4.66	1.50	2.44
July	70.7	103	41	3.47	1.27	8.78
August	69.2	98	36	3.26	0.23	5.09
Summer	68.9	....	....	11.39	3.00	16.31
September	61.1	99	.0	3.93	0.77	9.12
October	48.6	86	10	3.22	5.13	1.99
November	32.1	72	—15	1.67	1.79	0.65
Fall	47.3	....	....	8.82	7.69	11.76
Year	43.9	103	—40	32.96	20.57	42.95

Average date of first killing frost in autumn, October 1; of last in spring, May 10.

The extremes in temperature show a wide range. The highest ever recorded was at Wabasha, where 105° F. was reached, while the lowest was at Whitehall, where a temperature of –46° F. was once recorded. Such extremes are very rare, however, and of short duration.

Reference to the following figures gives the length of growing season in Buffalo County as compared with other portions of the state.

The average date of the last killing frost in the spring at Wabasha is May 1 and at Whitehall May 6. The average date of the first killing frost in fall at Wabasha is October 5 and at Whitehall October 4. This gives an average growing season at these two stations of approximately 150 to 155 days. On the higher elevations and in small valleys and ravines the season is somewhat shorter than at the stations where the records were taken. It is very seldom, however, that corn is damaged by early frosts, even where the growing season is the shortest. At Eau Claire the growing season appears to be a few days shorter than at the other two stations. The records from these three stations may be considered as representing fairly well the respective portions of Buffalo County having about the same elevations as the stations.

Good water is available in nearly all parts of the county, though on the higher ridges it is often necessary to drill to considerable depths. While there is overflow land along the larger streams, swamps are rare and healthful atmospheric conditions prevail throughout the region.

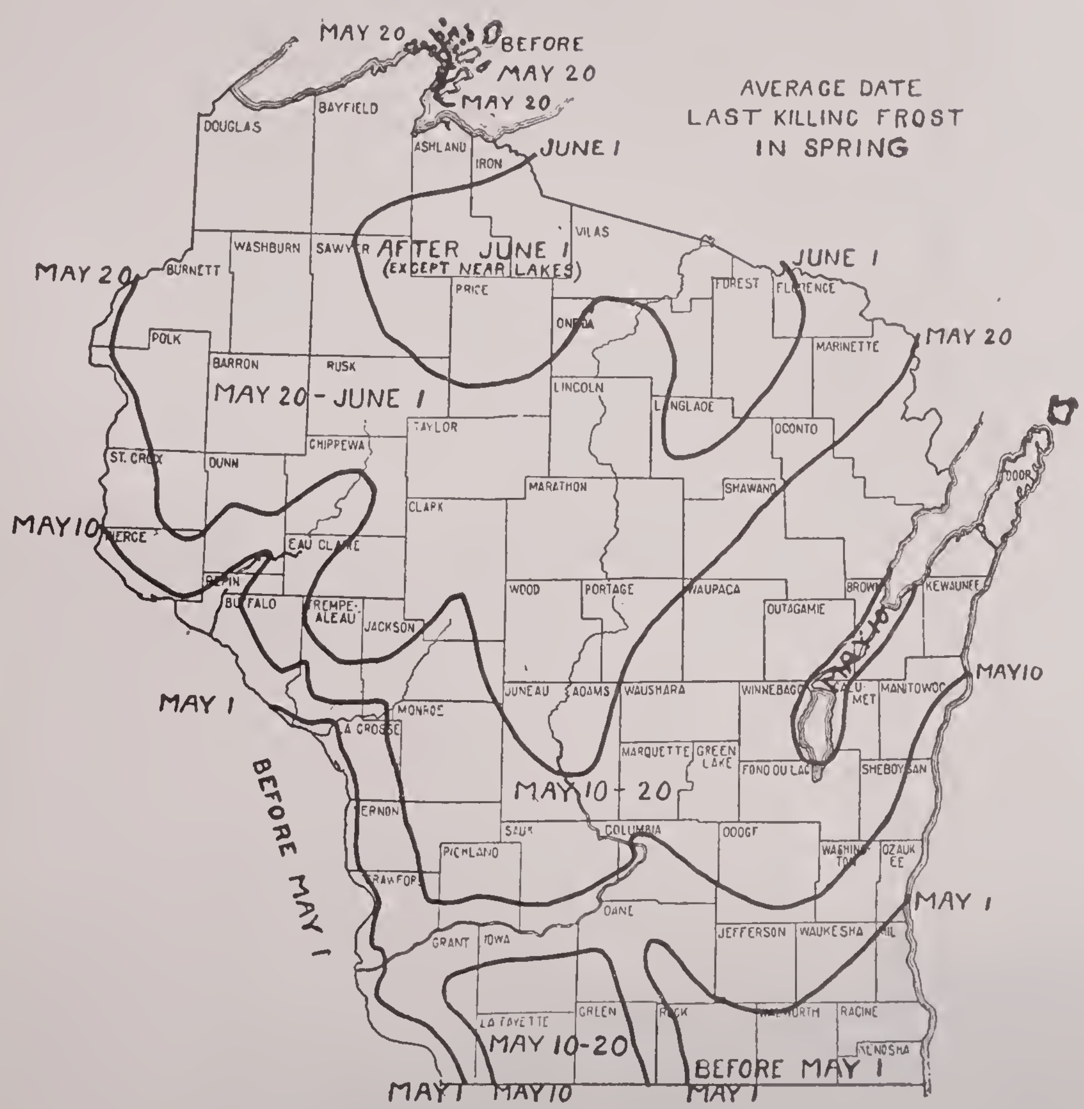

FIGURE 2. LAST KILLING FROST IN SPRING.

FIGURE 3. FIRST KILLING FROST IN FALL.

These maps have been prepared from the original monthly reports of the observers of the U. S. Weather Bureau for the past 12 years, supplemented by private records.

SUMMARY

Buffalo County is situated midway along the west State line of Wisconsin and comprises 687 square miles, or 439,680 acres. It may be divided broadly into two divisions, the valleys and the uplands. The topography of the valley is level to undulating, becoming gently rolling in a few places, and in the upland the surface is gently rolling to hilly. The slopes are usually steep and rocky. On the ridge tops and gentle slopes are found the most extensive areas of highly developed soil in the county.

The first settlements in the territory embraced within the county were made between 1845 and 1850. All parts of the county are now well settled.

Three railroad systems enter the county, and these with the Mississippi River provide adequate transportation facilities, except for interior points. Alma, the county seat, is 353 miles from Chicago, over the Chicago, Burlington & Quincy Railroad, and 89 miles from Minneapolis.

The mean annual temperature of the county is about 45° F. and the mean annual precipitation about 30.5 inches. The length of the growing season is about 150 to 155 days.

Over practically all the county agriculture is well developed and prospering. The leading type of agriculture is general farming, with dairying as the main feature. The crops most extensively grown are oats, hay, corn, barley, rye, and wheat. The steep slopes afford excellent pasture and are usually kept in grass to prevent erosion.

Buffalo County lies within the unglaciated portion of the State and the soils have been derived largely from the disintegration products of the underlying limestones, shales, and sandstone, although probably there has been influence in places by wind-blown material or loess, and from the material washed down from the slopes, transported by the streams, and deposited as terrace formations.

Including Rough stony land, Peat, and the Genessee Soils, 19 types and 3 phases of soil are recognized in the county.

The Knox silt loam, with its steep phase, is an extensive type and is found throughout the upland portion of the county. It

is a good general farming soil and upon it dairying is carried on quite extensively. It produces a better quality of grain than any of the other types.

The Waukesha series consists of dark-colored terrace soils, found as terraces along many of the streams throughout the county. This series includes some of the finest agricultural land in the county. The types mapped are the Waukesha silt loam, and gravelly sandy loam.

The Boone series of soils is derived from the disintegration of the Potsdam sandstone.

The Lintonia series forms the light-colored terraces throughout the county, but is not very extensively developed. The types mapped are the silt loam, fine sandy loam, and fine sand. The Lintonia silt loam is very similar to the Knox, except in topography and origin.

The Plainfield series of terrace soils includes the sand and fine sandy loam found along the Buffalo, Chippewa, and Mississippi Rivers. The fine sandy loam is used for general farming. farming.

The Bates series is similar to the Boone, but the soils are black instead of light colored. The types mapped include some of the best soil in the county. The Bates silt loam and fine sandy loam are recognized and mapped as belonging to this series.

Peat comprises areas of partially decomposed vegetable matter which occupy low, poorly drained positions, chiefly along streams. This soil is rather inextensive in Buffalo County.

Rough stony land includes rock exposures, cliffs, and land which is too steep and rough to cultivate profitably. It is only of value for the small amount of timber and pasture it supplies.

The Genessee soils include a fine sandy loam, silt loam and silty clay loam. Soils on flood plains of streams and subject to occasional or frequent over flow make up this series.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

W. O. HOTCHKISS, Director and State Geologist.
A. R. WHITSON, In Charge, Division of Soils.

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean.

BULLETIN NO. 54B **SOIL SERIES NO. 24**

SOIL SURVEY

OF

JACKSON COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB. AND T. J. DUNNEWALD OF THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY, SURVEY, AND A. L. GOODMAN, G. W. MUSGRAVE AND C. B. CLEVENGER OF THE U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS.

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS,
MILTON WHITNEY, CHIEF.
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

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INTRODUCTION

Before the greatest success in agriculture can be reached it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in cooperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the

Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: First, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture*, which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere.

Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis*, which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay.—Less than 20% silt.

Soils Containing Between 20–50% of Silt and Clay

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for ex-

ample, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sandy and gravelly loams. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey. By uniting the soil class with the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF JACKSON COUNTY WISCONSIN

CHAPTER I

DESCRIPTION OF AREA

Location and boundaries.—Jackson county is located in the west central part of Wisconsin, and has an area of approximately 978 square miles or 625,920 acres. It is bounded on the north by Clark and Eau Claire counties, on the east by Wood and Juneau, on the south by Monroe and La Crosse, and on the west by Trempealeau county. It has an extreme length east and west of forty-two miles. The eastern portion of the county is only eighteen miles wide, while the western two tiers of townships give the county a width of thirty-six miles.

Topography.—The surface features of the Jackson county fall into two very distinct divisions. The approximate boundary between the different zones is marked by the Black River from the southwestern corner of the county to a point three miles north of Black River Falls. From this point northward, the Chicago and Northwestern Railway Line marks the dividing line. The county to the west consists of a series of valleys and narrow ridges which give the region a hilly to broken topography. To the east the surface is nearly level.

Geological History.—In the early geological history of the region there was a smooth initial surface underlaid by limestone, with sandstone in turn beneath it. The lower Magnesian limestone which originally covered this region has practically all been removed by erosion, and remnants of the elevated plain-like surface have been reduced by weathering and erosion to very narrow, winding irregular ridges on which the outcroppings of sandstone are frequent. In but few cases in the county is there any tillable land on the narrow crest of these high ridges.

The headward streams from one drainage system have interlocked with adjacent systems so that the divides are crooked, rocky ridges. This gives the west half of the county a rolling, rugged appearance, the greatest irregularity of surface being along the western extremity of the county and becoming less pronounced going eastward to the Black River.

The eastern portion of the county consists of a very extensive sandy plainlike region where the surface is nearly level and from the floor of which there arise numerous cliffs of sandstone more resistant than the bulk of the underlying rock. These mounds form a conspicuous feature of the landscape.

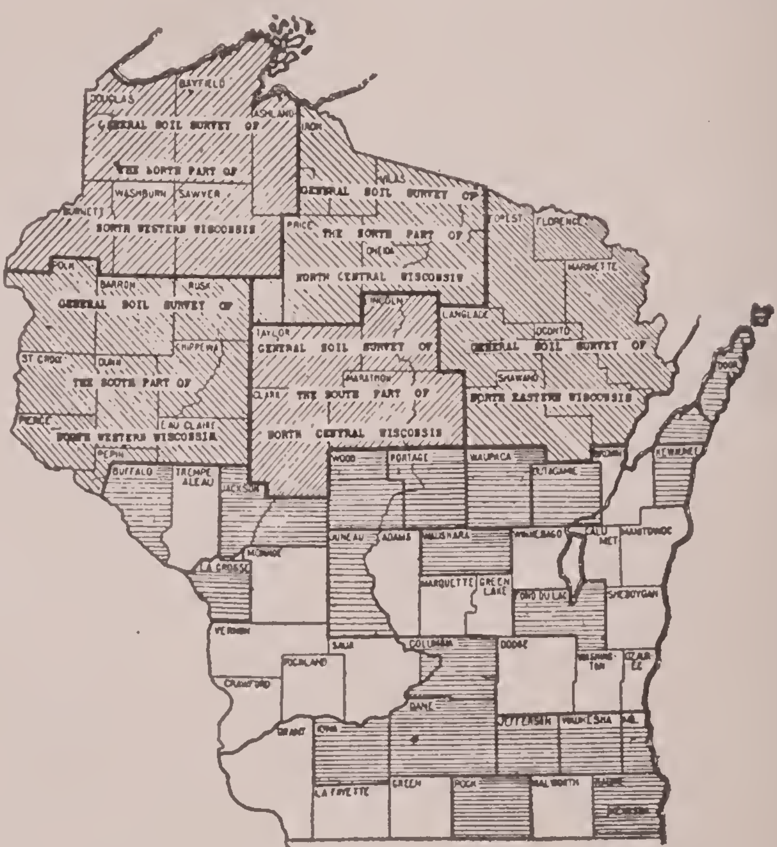

FIG. 1. SKETCH MAP SHOWING AREAS SURVEYED IN THE STATE.

Much of the eastern portion of the county within this sandy plain is low and poorly drained, and includes extensive marsh areas made up largely of peat. These marshy areas are most extensive in the extreme eastern tier of townships where over from 75 to 80 percent of the land area is marsh.

Throughout the marshy tracts and within the regions where shale layers occur with the sandstone as well as along the first bottoms of streams, the natural drainage is deficient. Elsewhere the natural drainage is good.

Water courses.—The Black River which enters the county near the center of the north side and leaves at the southwest

corner, receives the drainage waters from the greater part of the area. From the east it receives the drainage waters from the East Fork of the Black River, Morrison Creek, Perry Creek, Robinson Creek and others, while from the west it receives Halls Creek, Town Creek, Roaring Creek, and Douglas Creek. The extreme western border of the county drains westward chiefly through tributaries of the Trempealeau and Beef Rivers into the Mississippi. From the southeastern portion of the county some of the drainage water reaches the Wisconsin River through the Lemonweir River and its tributaries.

Settlement.—The first settlement in Jackson county was made in 1818 or 1819 when a saw mill was erected on Town Creek, but this was not permanent. The Indians did not cede away their right to the region until 1838, and in 1839 the first permanent settlement was made on the present site of Black River Falls. The Mormons bought a mill here in 1843 which they operated for part of two years. Later a Mormon settlement was established at Knapp in the country to the east of Millston. Jackson County was established in 1853, and the village of Black River Falls was incorporated in 1866.

Black River Falls, with a population 1,796 in 1920, is the county seat of Jackson county and also the largest city. It is situated on the Black River near the center of the county, and is a distributing center, market and shipping point for a large territory. Merrillan, Hixton, Taylor, Hatfield, Pray, and Millston are smaller railroad towns. In 1920 Jackson county had a population of 17,746.

Railways.—Two railway systems traverse the county. The Chicago and Northwestern Line crosses the area from the southeast to the northwest passing through Millston, Black River Falls, and Merrillan. From Merrillan a branch runs northeast through Neillsville, Marshfield, and Wausau, to Green Bay. From Fairchild, just above the north county line a branch extends west to Mondovi in Buffalo county. The Green Bay and Western Railway crosses the county from east to west passing through Pray, Hatfield, Merrillan, Hixton, and Taylor. The southwestern corner of the county is more remote from railroad facilities than any other section of the area, but this has not prevented the development. In fact this is one of the best improved and most highly prosperous farming communities in the

county, and centers about the inland town of Melrose which is connected with Black River Falls by stage.

Highways.—The main dirt roads throughout the western part of the county are usually graded and kept in good condition, as the predominating soil material usually makes a good roadbed, but hills are numerous and grades are frequently steep; so heavy hauling is difficult. Throughout the sandy portion of the county most of the roads are very sandy, but in some instances shale or clay, where available, has been used in improving the highways with very satisfactory results.

Other improvements.—At Hatfield there is a large dam across the Black River just above the rapids, and this forms an extensive reservoir known as Lake Arbutus. A power house is located several miles south of the dam, and from here the electric power is carried over high tension transmission lines to La Crosse and other points.

Nearly all parts of the county are supplied with rural free delivery service, and telephones are in common use.

Markets.—The towns within the area afford markets and shipping points for the farm produce raised. From Black River Falls to Madison, it is 127 miles and to Milwaukee 209 miles. It is 250 miles to Chicago, and 152 miles to Minneapolis, Minnesota.

Farm equipment.—The farm buildings and equipment in the Knox silt loam and Boone fine sandy loam and loam country are generally modern and up to date in all ways. In the vicinity of Melrose and the north side of the Trempealeau River valley, large barns and silos, electric lights and water supply systems are common. A number of farms use tractors, although the amount of steep and rough land precludes the use of some types of tractors for field work.

In the more sandy districts, farm buildings are generally less pretentious, occasional abandoned farms are seen, and equipment and machinery are of a less complete order. Although there are sometimes very good buildings and equipment on sandy farms, the general condition of these is usually a fair indication as to the fertility of the soil or the profitable nature of the farming done.

Farm tenure and labor.—Of the 2577 farms is Jackson county reported by the United States census of 1920, the greatest number, 991, lie between 100 to 175 acres in size, 622 farms were 50 to 99 acres in size, and 425 were 175 to 260 acres in size. Moderate to large size farms are the rule, although where special crops are grown exclusively the farms are often much smaller. 86.3 per cent of the farms are operated by owners, 12.7 per cent by tenants, and 1 per cent by managers.

Labor on farms is generally American born, obtained from the immediate locality. Prewar wages were from $30 to $40 per month with board, although during the last few seasons as much as two times this price has been paid due to war conditions. In general, farm help is scarce and the special crops such as tobacco and cucumbers have been reduced in acreage on many farms because of the labor shortage.

Land values.—Farm land ranges greatly in price. The best land in the well developed Knox silt loam country often sells for $100 to $200 an acre, and an occasional wooded poorly located piece can be bought for $35 to $40. In the east half and the sandy districts, wild land may be had for $5 to $20 per acre and partly developed land for from $20 to $40 per acre. Values in all parts of the county vary greatly depending upon location, lay of the land, improvements, soil, and the manner in which fertility has been kept up. The producing capacity of farms in each district varies even on the same soil according to the methods followed, and the personal equasion of the farmer must always be considered in passing upon the value of a farm.

SOILS

Jackson county lies almost entirely within the unglaciated portion of Wisconsin, and in its geological formations, soil conditions, and topography, it is representative of large areas in the central and southwestern parts of the state.

Throughout nearly all of the county the uppermost rock consists of Potsdam sandstone. Over the western portion of the area this rock outcrops in numerous places forming the steep rocky slopes of valley walls, isolated mounds or long narrow ridges where the rock has been more resistant to processes of weathering. In the eastern portion of the county there are also

numerous isolated mounds of sandstone which, as indicated elsewhere, form a conspicuous feature of the landscape.

The outcrops of this rock determine the classification, and make up a considerable portion of the type mapped as Rough Stony Land.

Granitic rocks form the bed rock formation along the Black River from Black River Falls north. In the immediate vicinity of City Point, in the extreme eastern part of the county, the surface rock is also granite.

From the standpoint of soils, the whole county may be considered as being unglaciated, but along the extreme northern border of the county, there are various indications of glaciation. These are chiefly glacial bowlders and gravel in places. No pronounced moraine is found there. The glaciation represented is Pre-Wisconsin, and because of its extreme age and that its action along the southern border was very feeble, the influence on the present-day soils is not sufficient to recognize in our soil classification of Jackson county.

The surface of nearly all of the western portion of the county is covered to a depth of from less than two feet to over ten feet, with a mantle of extremely silty material which is undoubtedly loess. It is extremely silty at the surface, the clay content gradually increasing with depth, and in cuts a laminated structure is often observed. This material is supposed to have been deposited by action of the wind, following early glacial periods. It is extremely fine in texture having a smooth feel like flour.

At one time this entire western portion of the county was doubtless covered with this material, which has been removed by erosion in places, especally where the deposit was thin, and the underlying sandy material or sand rock was exposed.

In the survey of Jackson County, the various soil forming materials have been classified into ten soil series and nineteen soil types, not including peat and rough stony land. In a number of instances phases of types have been recognized. The soil series, which correspond to the family groups, are not shown on the map, which accompanies this report, and the series are described here only briefly. The individual soil types, however, are shown on the map, each being indicated by a distinct color. It is the soil types in which we are especially interested since the type is the unit in mapping and classifying soils. Following is a complete list of the soil types mapped in the county, and

the series or family group to which each type belongs. Following this general discussion of the soils will be found a full and detailed description of all of the types, together with statements covering the present uses of the soils and methods through which each type can be best improved.

The soil derived in part from the loessial blanket and partly from decomposed shale has been classified as Knox silt loam. This is the most extensive soil in southwestern Wisconsin. No other type was mapped in this series.

Along stream valleys throughout the western part of the county, scme terraces or benches occur where the soil is rather heavy, and where it has been derived from the uplands and redeposited by water. There soils are of the Lintonia series, and include the silt loam only.

The Bates series comprises dark-colored upland soils in the loessial region where the original timber was thin or sparce and where a semi-prairie condition prevailed. The silt loam was the only type mapped.

In the stream bottoms of the western part of the county where the soils are dark-colored and rather heavy in texture, the Wabash series has been mapped. The types Wabash silt loam and loam were found.

On many of the slopes in western Jackson County and over extensive tracts in the eastern part of the area, the material forming the soil has been derived directly from the weathering of the Potsdam sandstone. This material has been classified as the Boone series, and the types Boone loam, fine sandy loam, fine sand, with several phases were indicated on the soil map.

In a number of places, especially in the north central and northeastern portions of the county the Potsdam sandstone has a shaly phase associated with it, and from the weathering of this material has come the Vesper series of soils. The surface is level, the soils are shallow over the shaly rock, and usually contain varying amounts of clayey material in the subsoil from the shale, which makes a tight subsoil and poor drainage. The types mapped are Vesper silt loam, fine sandy loam, and sandy loam.

Along Black River and its tributaries are extensive tracts of alluvial land now found as terraces well above present flood flow. The soil is light-colored and light in texture, and has

been classified as the Plainfield series. The types mapped are Plainfield sandy loam, sand, and fine sand.

Throughout the eastern portion of the county are numerous areas of marsh border soil which are dark-colored, low-lying, and naturally poorly drained, and where the soils are of a sandy nature, partly residual and partly alluvial, and aways acid. These soils are placed in the Dunning series, and have been classed as Dunning sand.

The first bottom light-colored soils subject to annual flooding have been classified as Genesse, and the types silt loam, fine sandy loam, and fine sand were mapped. Extensive areas of peat were also mapped, and this consists of decaying vegetable matter in various stages of decomposition, with which there is mixed a small amount of fine earth, but seldom enough to permit the use of the term Muck.

The following table shows the actual and relative extent of each soil type, and in the following pages of this report each type is fully described.

AREAS OF DIFFERENT SOILS

Soil	Acres	Per cent	Soil	Acres	Per cent
Boone fine sand	111,744		Boone loam	22,400	3.5
Level phase	14,656	20.1	Plainfield fine sand	18,880	2.9
Poorly drained phase	2,176		Wabash silt loam	7,808	1.2
Knox silt loam	73,920	18.9	Wabash loam	7,488	1.2
Steep phase	47,296		Genesee silt loam	7,296	1.1
Peat	89,536	15.7	Vesper silt loam	4,800	.8
Shallow phase	10,752		Genesee fine sandy loam	3,072	.5
Boone fine sandy loam	54,400	8.5	Bates silt loam	2,624	.4
Rough stony land	42,496	6.6	Lintonia silt loam	2,368	.4
Vesper fine sandy loam	40,000	6.2	Vesper sandy loam	2,368	.4
Dunning sand	37,888	5.9	Plainfield sandy loam	1,536	.2
Plainfield sand	35,136	5.5			
			Total	640,640	

CHAPTER II

GROUP OF HEAVY SOILS

KNOX SILT LOAM

Extent and distribution.—The Knox silt loam all lies west of the Black River. This is an important and extensive type of soil in Jackson County, the towns of Melrose, Franklin, Garden Valley, Albion, Irving, Currian, and Northfield being made up largely of it.

Description.—The surface soil of the Knox silt loam consists of twelve inches of a grayish-brown or buff-colored silt loam, having a friable structure and a smooth feel. While there is present a small percentage of fine and very fine sand, but few coarser grains are found. The lower portion of the soil usually is of a yellowish color, but on drying, the surface becomes ashen in appearance. As a whole, the texture of the material is very uniform, but varies somewhat in depth. The subsoil consists of a heavy, yellow silt loam, grading into a silty clay loam at eighteen to twenty inches, and usually becoming a light chocoate brown color at thirty to thirty-six inches. It is compact, and is uniform throughout its entire extent, except as indicated in the phase described below. The underlying rock lies from four to ten or more feet below the surface.

The most important variation in this soil has been designated as the steep phase on account of its steep slopes and rough, uneven topography. This phase is described in greater detail following the description of the typical soil.

Minor variations in the typical soil occur, chiefly on the narrow ridges, where the surface soil has in places been removed and the heavy subsoil exposed. In such places the depth to the underlying rock is also less than over the more extensive areas of this soil, and in some instances it can be reached with a three-foot auger. On some of the lower slopes, the wash from the adjoining higher land has accumulated to a small extent,

and the surface soil in such places is somewhat deeper than the average. On some slopes the soil is somewhat darker in color and contains more organic matter than typical. While a number of such minor variations occur, this soil—as a whole—is remarkably uniform.

Topography and drainage.—The Knox silt loam occupies a section of country which consists of a series of hills and ridges. The typical Knox silt loam is found occupying the tops of these hills and ridges where the surface is nearly level to gently rolling, and also the more gentle slopes where erosion is not a serious problem, and where all ordinary farm operations can be carried on without difficulty. On the steeper phase, the fields are subject to erosion, and in some places deep ravines and gullies have been formed, causing considerable damage. Practically all of this phase can be cultivated, though some of it is sufficiently steep to make the operation of farm machinery difficult. Erosion is the most serious problem to be considered in the cultivation of the steep phase. On account of the uneven character of the surface, the natural drainage is good. The type is quite retentive of moisture, and suffers from drought only during long dry spells.

The topography is such that drainage on this soil is almost always efficient, and only in isolated spots will the drainage ever need to be improved.

Origin.—The Knox silt loam in Jackson County lies directly over sandstone rock which underlies all the ridges and knolls at from two to ten feet beneath the surface. The surface soil is partly of loessial origin, having been deposited as fine dust by winds from the south and west in past geological ages. It is often noticeable that slopes which would be exposed to such winds are but thinly covered with the silt loam or the soil is sandy while in the lee of hills and ridges, the silt loam surface soil is often deeper than ordinary. This soil is also derived in part from shale associated with the sandstone.

Most of this soil shows varying degrees of acidity; so much so that difficulty in getting alfalfa started will generally be experienced unless the soil is limed, heavily manured, and inoculated.

Native vegetation.—The natural timber on this soil in Jackson County consisted mainly of white, black and bur oaks, with

some white birch, basswood, maple and white pine. Most of the soil having fairly level or undulating topography has been cleared and cultivated for many years. A large part of the steep phase is still timbered as are a few of the more isolated forties which are not steep. The timber is mostly second growth oaks, poplar, and white birch.

Present agricultural development.—The principal crops grown at the present time and the average yields obtained are as follows: Corn, 40 to 45 bushels; oats, 35 to 45 bushels; barley, 30 to 35 bushels; wheat, 20 to 25 bushels; and hay 2 to 2½ tons per acre. Oats are grown more extensively than any other grain crops. The acreage of barley is smaller than that of oats and the acreage devoted to wheat is still less. The quality of the small grains grown on the Knox silt loam is excellent, and this soil is generally held to be a better grain soil than any of the other soils of Jackson County. Corn, on the other hand, does not do so well on this type as on the darker-colored soils of the Wabash or Bates series, though the crop is successfully grown where ever this soil occurs. Most of the grain and corn grown is fed to stock on the farms, though elevators at Hixton, Fairchild, and Taylor, and numerous grist mills still ship much oats and barley and some wheat. Where the land is well farmed, but little trouble is experienced in growing clover. When the snowfall is light, the alternate freezing and thawing of the ground sometimes kills out clover. Pasturage, in general, is excellent, being scant only in very dry weather, or on shallow slopes or knolls exposed directly to the sun.

Buckwheat, rye, and sorghum are produced on this soil, but their acreage is never large. Alfalfa is successfully grown by very few farmers though the acreage will no doubt be gradually increased, as the crop provides excellent feed, which is of great value, especially to the dairy farmers. Potatoes are grown for home use on practically every farm, but seldom on a commercial scale. Tobacco is grown to some extent, but the crop is generally grown on lighter soil. Beans and peas are not extensively grown on this type. Garden crops, such as strawberries, tomatoes, lettuce, radishes, and cucumbers, and bush berries all do well and are grown for home use, but seldom on a commercial scale.

Fruit growing is not an important industry; though most farms have a few fruit trees, and there are a few fairly large orchards.

Farm buildings are generally in good condition, and silos are rapidly coming into general use especially in the towns of Albion, Springfield, Hixton, North Bend, and Alma.

Large numbers of cattle, hogs, and calves are raised and sold as a part of the business of dairying. Stock buyers located at Fairchild, Black River Falls, Hixton, Taylor, and Humbird operate over adjoining territory.

The rotation of crops most commonly practiced is that of a small grain crop with which clover and timothy are seeded, hay being cut for two years after which the land is plowed for corn.

When wheat is grown, it may take the place of the second grain crop. Hay may be cut for two years or the field may be pastured one year after being cut for hay the first year. On the steep slopes corn is sometimes omitted from the rotation because the land is more apt to erode when in an intertilled crop than when in a grain crop or in grass. The steepest slopes which are used are often kept in grass for the greater part of the time, though some attempt to cultivate crops on land of this character is made. Stable manure is usually applied to the sod to be plowed for corn.

Nearly every farmer produces enough potatoes for home use and many have some to sell each year. The yield is usually about 150 bushels per acre. The soil is not as well adapted to this crop as some of the other types, especially the sandy loams, though the quality of the potatoes grown is fair.

Tobacco was at one time more extensively cultivated than at present. It is generally grown on the same field for four years in succession, but during the first two or three years the yields are best. The fields must be heavily manured, and this is often done at the expense of the remainder of the farm. Tobacco usually follows potatoes or corn, and is often followed by wheat. The yieds secured range from 1,000 to 1,600 pounds per acre. Since the crop requires careful attention and considerable labor, the acreage devoted to it on any farm is comparatively small.

Alfalfa is being tried by a few farmers, and some have secured a good stand without inoculating the soil. In order to secure the best results, however, the soil should be inoculated and liming is also necessary, since the type is slightly acid.

View showing typical crops and topography in Knox Silt Loam country north and west of Hixton, Jackson County. This soil is good grain land.

Binding grain on a rolling portion of the Knox Silt Loam. Land slightly steeper than this is mapped as Steep Phase where measures to prevent erosion or washing of the soil are necessary.

Trucking and small fruit growing are not carried on to any great extent; though the ordinary garden vegetables and berries are grown for home use, and limited quantities are marketed in the near-by towns. There are a few small apple orchards, though the fruit industry has not received special attention on this soil.

KNOX SILT LOAM—STEEP PHASE

Extent and distribution.—The steep phase of the Knox silt loam occurs in all parts of the county intimately associated with the main type, and frequently grades into it in such a way as to make the drawing of a definite boundary line difficult. It occupies steep slopes generally about the heads of small streams heading in the areas above the rough stone land. On these slopes, which form the more or less steep sides of the valleys, the silt soil is subject to erosion and careful methods are often necessary to prevent destructive gulch formations while these slopes are under cultivation. When the steep slopes are not wooded, or in pasture, or covered by a growing crop to protect them, the soil washes badly, and ditches are quickly and deeply cut into the hillsides. When erosion has once started in this way, it is difficult to check; so methods of prevention are very important.

Description.—In general physical appearance and character, the soil of the steep phase is essentially like the typical soil, the basis of separation being one of topography. As a whole, the color and texture of the soil may be slightly lighter than the typical soil, and the average depth to rock is less. Because of its steep, broken character, this phase has a lower agricultural value than the typical soil.

Drainage.—The natural drainage of the steep phase is good except in small areas along the slopes where springs and seeps may occur. The greater part of it is so rolling that too large a percentage of the rainfall runs off, and crops often suffer from lack of moisture.

Origin.—The Knox silt loam, steep phase, has practically the same origin as the typical soil, though as a rule there is less depth to bedrock, and chert fragments occur on the surface and through the soil mass in greater abundance.

Native vegetation.—The original timber growth consisted of the same trees as on the typical soil, oak predominating. Most of the standing timber outside the bottom lands is now found on this phase, and on the rough stony land with which it is associated, though a considerable proportion of the steep land is cleared, and is either in cultivation or pasture land.

Present agricultural development.—The same crops are grown on the steep phase as on the typical soil, but less corn and other intertilled crops are grown and more of the land is in grass and pasture than on the main type. The ordinary yields of all crops are somewhat lower. Because of the steep character of the surface, the phase is more difficult to work than the typical soil. The steepest portions of the phase are now in timber or pasture land, and the remainder is devoted to general farming.

LINTONIA SILT LOAM

Extent and distribution.—This soil occupies part of the highest levels of the terraces bordering the Black and Trempealeau Rivers. The soil quite closely resembles the Knox silt loam in texture and color, but differs from it in topography, origin, and the position which it occupies.

Description.—The surface soil of the Lintonia silt loam to an average depth of ten inches consists of a brownish-gray, friable silt loam, which becomes lighter colored on drying and frequently has a whitish appearance. The quantity of organic matter present in the surface soil is comparatively small, and this accounts in part for the light color of the material. A slight acid condition has developed in places in the surface soil, as indicated by the litmus paper test. The subsoil consists of a yellowish-brown or buffcolored silt loam, which usually becomes somewhat heavier and more compact with depth, and at twenty-four to thirty inches may be a silty clay loam. Below this depth there is often a considerable quantity of fine and very fine sand, and this mixture extends to a depth of three feet or over, and grades into stratified fine sand with layers of gravel in the lower depths.

Topography and drainage.—The surface of the Lintonia silt loam is usually level or nearly so, frequently having a gentle slope toward the stream channels along which it occurs. The

type occurs as terraces or benches usually rather narrow, but extending along the streams for considerable distances. The part adjoining the upland rises slowly and frequently grades into the Knox silt loam so gradually that the boundary line must be arbitrarily placed. As this type is found chiefly at the foot of higher lying slopes, which are often very steep, large quantities of water must pass over the terraces during heavy rains, and as a result deep ravines are frequently formed. The original timber growth consisted chiefly of oak, with some hickory and a few other species. Most of the timber has been removed. In the ravines there is now a second growth of sumac, hazel, and other brush.

Origin.—The material composing the type is largely of alluvial origin and was deposited during glacial periods when the melting ice sheets to the north greatly increased the volume of water flowing down these rivers. It is probable that the surface material, especially close to the foot of the bluffs, is partly colluvial, having been washed down the steep slopes from the Knox sit loam areas, which are always found at higher elevations.

Present agricultural development.—Practically all the type is put to some agricultural use, and most of it is cultivated regularly. The crops generally grown and the yields obtained are: Corn, 45 to 50 bushels; oats, 25 to 40 bushels; barley, 30 to 35 bushels; and hay, 1½ to 2 tons per acre. Potatoes are grown on the type to a small extent for home use, but seldom on a commercial scale. The usual rotation consists of corn followed by a small grain, either oats or barley, or sometimes by one year of each of these crops, and then by clover and timothy mixed, seeded with the grain, the field being cut for hay one or two years, before returning to corn. The stable manure is usually applied to the sod to be plowed under for the corn crops. The methods of cultivation, fertilization, and treatment are practically the same as those practiced on Knox silt loam. The soil is not difficult to cultivate, and where the areas are of sufficient size to form fields or the larger part of a farm, this terrace soil may be considered one of the most desirable types in the county.

BATES SILT LOAM

Extent and distribution.—This type of soil is all found in one locality. It covers four to five square miles of land just north and west of the town of Alma Center. The soil is nearly level to undulating, occupying part of valley flat and extending up adjoining slopes and includes small knolls and elevations. There is sufficient fall so that the drainage is generally good, although where the land is quite level, the drainage is deficient in places.

Description.—The surface soil of the Bates silt loam to a depth of ten to fourteen inches consists of a dark-brown silt loam containing a high percentage of organic matter. Its high percentage of silt and organic matter gives the soil an extremely smooth feel. Litmus paper tests indicate an acid condition over most of the type. The subsoil consists of a brown or buff-colored silt loam, which gradually becomes heavier in texture and lighter in color, and at twenty-four to thirty inches consists of a yellowish-brown, compact, heavy silt loam or silty clay loam. In spots where the drainage is deficient, the subsoil shows a slight mottling of light gray or drab. This heavy subsoil extends to a considerable depth, and the soil section will probably average seven to eight feet in thickness.

Origin.—The silty material composing this type of soil may be of residual origin from a shaly phase of the Potsdam sandstone formation, or more probably, loessial material. It differs from the Knox silt loam principally in its higher organic matter content.

Native vegetation.—The type as a whole is generally spoken of as "Oak openings" having been originally forested with scattered clumps of large oak trees, while the intervening spaces were in a semi-prairie condition, supporting a more or less heavy growth of prairie grass.

The Bates silt loam is one of the desirable types of soil in the county. All the general crops grown in the region do well on this type, and the average yields of some of the crops are higher than on most of the other soils. The soil is especially well adapted to corn, on which the ordinary yield is 50 to 60 bushels per acre. Barley produces 30 to 35 bushels and oats 40 to 50 bushels per acre. The quality of the small grains is

not so good as of those grown on the Knox silt loam. Clover and timothy produce from 1½ to 2 tons per acre, and the pasturage is generally excellent. The rotation of crops most generally followed consists of corn, small grains, and hay. Of the small grains, oats is most commonly grown, though barley may also be grown in the rotation following the oats. Where the acid condition is corrected and the soil inoculated, the alfalfa crop promises to do very well.

Dairying is the chief branch of farming followed, and hog raising is carried on quite extensively on many of the dairy farms. The buildings and other improvements on this soil are as a rule better than the average. Some farms produce beef stock in connection with dairy farming. Silos are in quite general use.

VESPER SILT LOAM

This soil consists of eight to ten inches of grayish brown heavy silt loam on yellowish-brown or bluish, or mottled silty clay loam subsoil. This subsoil is sticky and retentive of moisture. Lenses of fine sand may occur in the clay subsoil and beneath this clay, a layer of sand, or sandy clay loam lies at from twenty-four to thirty-six inches. The sandy material lies nearest the surface on slight knolls while on the flats and depressions, the clay subsoil may extend to four feet or more in depth. In a few places, shale or sandstone rock is found within three or four feet of the surface especially on the slight knolls. On the flats, one to three inches of the surface soil may be black with accumulated organic matter.

This Vesper silt loam covers about five to six square miles of land immediately to the north and west of Merrillan. The soil is not found in any other part of the county.

The topography of this soil is level or very slightly sloping. Very slight elevations or knolls occur in a few places. These have been outlined and indicated by the symbol (R) as rolling phase of the type.

The drainage of the type is generally poor. This is due to the combined effects of a sticky clayey subsoil and the level topography. The drainage is so defective that cultivated crops can seldom be matured on it except in dry season. The slight knolls mentioned are well enough drained so that the soil can generally be cultivated. Much of the land is retained in perma-

nent pasture or hay land. A large part of this soil is still timbered or brush covered. The original timber was largely pine with some hemlock, hardwood, and oak. Practically all the merchantable timber has been removed. The present timber consists of oaks, poplar, ash, and birch fifteen to twenty feet high. Grass, willow, and alder cover the lower portions. The soil is very acid, and a good deal of moss grows on the cleared land.

The crops best adapted to this soil are hay (alsike and timothy), root crops, rye, and oats. Corn for ensilage can generally be grown and in dry years ripe corn can sometimes be produced. Most of the cultivated crops are grown on the knolls. Potatoes are grown to some extent as well as buckwheat. Yields of all crops except hay are very variable, and depend almost entirely upon the character of the season.

This land sells for from ten to forty dollars per acre depending upon location and improvement.

The following table gives the mechanical analyses of samples of the soil and subsoil of Vesper silt loam.*

Mechanical Analysis of Vesper Silt Loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
212819	Soil	1.4	4.5	2.5	15.3	16.3	41.9	14.9
312820	Subsoil	.6	4.4	2.9	17.0	24.9	33.9	16.2

* The numbers used to identify these samples are the numbers of the U. S. Bureau of Soils, the analyses having been made by the Bureau.

CHEMICAL COMPOSITION, FERTILITY AND IMPROVEMENT OF HEAVY SOILS

The heavy soils have a fairly good supply of the mineral elements of plant food. The Bates soil as its dark color indicates, is especially well supplied with organic matter, nitrogen and a good amount of phosphorus. The lighter colored Knox and Lintonia soils are considerably lower in nitrogen and also phosphorus. The Vesper soil is fairly well supplied with all the essential plant food elements but on account of its acidity and lack of efficient drainage, measures to make these stores of plant food available for crops are necessary. Average analyses

indicate the following amounts of nitrogen, phosphorus, and potassium in these soils in pounds per acre, eight inches deep:

	Nitrogen	Phosphorus	Potassium
Average of Lintonia and Knox silt loams	1,988	820	33,800
Vesper silt loam	4,566	1,920	------
Bates silt loam	5,340	1,440	35,200
		(In pounds)	

It will be seen that there is a good deal of variation in the amounts of the plant foods found in these different soils.

Nitrogen and organic matter.—The light colored Lintonia and Knox soils have the smallest amounts of these elements. They can best be added to the soil by growing and plowing under green crops as clovers and alfalfa. Organic matter added to these soils helps prevent erosion or washing away of the soil, helps prevent drying out by increasing the water holding capacity of the soil, and enlarges the leaf and stem growth of crops giving larger straw on the grain crops and improved yields of silage and corn.

Acidity and liming.—Since all of these soils are medium to strongly acid and usually show need of lime, difficulty with growing clover and alfalfa may be corrected in part by applying ground limestone. The soil should be tested before this application, and this is done without charge by the University Soils Department at Madison. The need for lime as shown by the crops should also be considered. It should not be expected that lime will remedy conditions where the soil lacks good underdrainage as is often the case on the Vesper silt loam.

Phosphorus.—The Knox and Lintonia soils are lowest in the supply of this element, and although they are and have been the best grain soils in the county, if the farm does not produce enough manure to revive the soil where grain is becoming poor, small applications of phosphate fertilizer to help out the manure will be necessary. Even if the supply of manure is liberal the additional use of phosphate fertilizer will usually pay. Lodged grain or light yield may be laid in part to an unbalanced ration of plant food in the soil and addition of lime and small amounts of phosphorus fertilizer often help to remedy this condition.

Potassium.—*These soils are all so well supplied with this element that no artificial application probably will be needed on general farm crops, when manure is used, unless in some places on the Vesper soil where the drainage may be improved, it may be found necessary to apply some of this fertilizer at first until the supplies in the soil become available through cultivation and exposure of the soil to the air.

Crops—†The Knox and Lintonia soils are best adapted to grains and grass and fairly so to corn, while the Bates soil produces the best corn and barley. The Vesper soil produces hay well (alsike and timothy) and fair oats, rye, and a little corn. Methods to improve the surface and underdrainage must be worked out to improve yields on this soil.

In cultivating the Knox silt loam, it should be kept in mind that the soil is low in organic matter, and that much of it is subject to erosion. The supply of organic matter may be increased by supplementing the stable manure with green crops, especially legumes, plowed under. The second crop of clover may well be utilized in this way. Erosion may be held in check by putting the steepest slopes in grass. When necessary or desirable to cultivate the steeper slopes, the plow should be run at right angles to the slope. The drainage channel down the hillside is sometimes left as a shallow sod ditch, while the remainder of the field is cultivated.

The steep parts of the type should be kept in grass as much as possible, and dairying and stock raising are good lines of farming to follow.

There are many good orchard sites on the Knox silt loam. Bushberries, strawberries, etc., do well, and it would seem that such fruits might be profitably grown on a commercial scale since much of the type is within easy reach of shipping points. shipping points. The growing of apples has been developed in these and it is believed that apples could be successfully grown on a larger scale in Jackson county than at present.

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*For more information on commercial fertilizers and their uses see page 73.

†For more data on crop rotation, etc., see page 64.

CHAPTER III

GROUP OF MEDIUM HEAVY SOILS

BOONE LOAM

Extent and distribution.—This soil is a gradation between the loessial Knox silt loam and the more largely residual Boone fine sandy loam. This soil is generally distributed over the western half of the county, and occupies gently undulating secondary slopes or nearly level areas lying between the higher land of heavier soil and the streams border areas of fine sand or fine sandy loam. The soil usually lies on a valley slope. This type covers a total area of 22,400 acres.

Description.—The Boone loam consists of a grayish-brown loam or very fine sandy loam eight to ten inches deep on a yellowish-brown loam or sticky clayey sandy loam subsoil. The subsoil is variable, being generally a compact sandy loam on the knolls and a heavy loam or sandy clay loam on the slopes and the level areas. In some cases sand or sandstone is found at less than three feet on knolls, but in most cases the heavy subsoil extends beyond the reach of a forty inch auger.

Topography and drainage.—The drainage of the soil is nearly always good due to the generally sloping or undulating topography. The only exceptions are in the drainage ways, or bordering lower ground where small areas of the soil may be insufficiently drained at times.

Present agricultural development.—The Boone loam is a valuable soil, and is highly developed farm land. Practically all of it is under cultivation. Dairying and general farming are practiced on this soil. The crops grown include oats, barley, clover, corn, and some potatoes, wheat and root crops.

Yields of crops are about as follows: Corn, 50 to 70 bushels; oats, 30 to 40 bushels; wheat, 25 to 30 bushels; barley, 20 to 30 bushels per acre. Clover does well but often freezes out in winter. Improved land sells for from sixty to ninety dollars an acre depending on its location, improvement, etc.

BOONE FINE SANDY LOAM

Extent and distribution.—The Boone fine sandy loam is an important and fairly extensive type of soil in this county, covering a total of 54,400 acres. Considerable areas of this soil are found in the towns of Cleveland, Hixton, Alma, Springfield in the western part of the county, and also in the vicinity of Shamrock in the southern part.

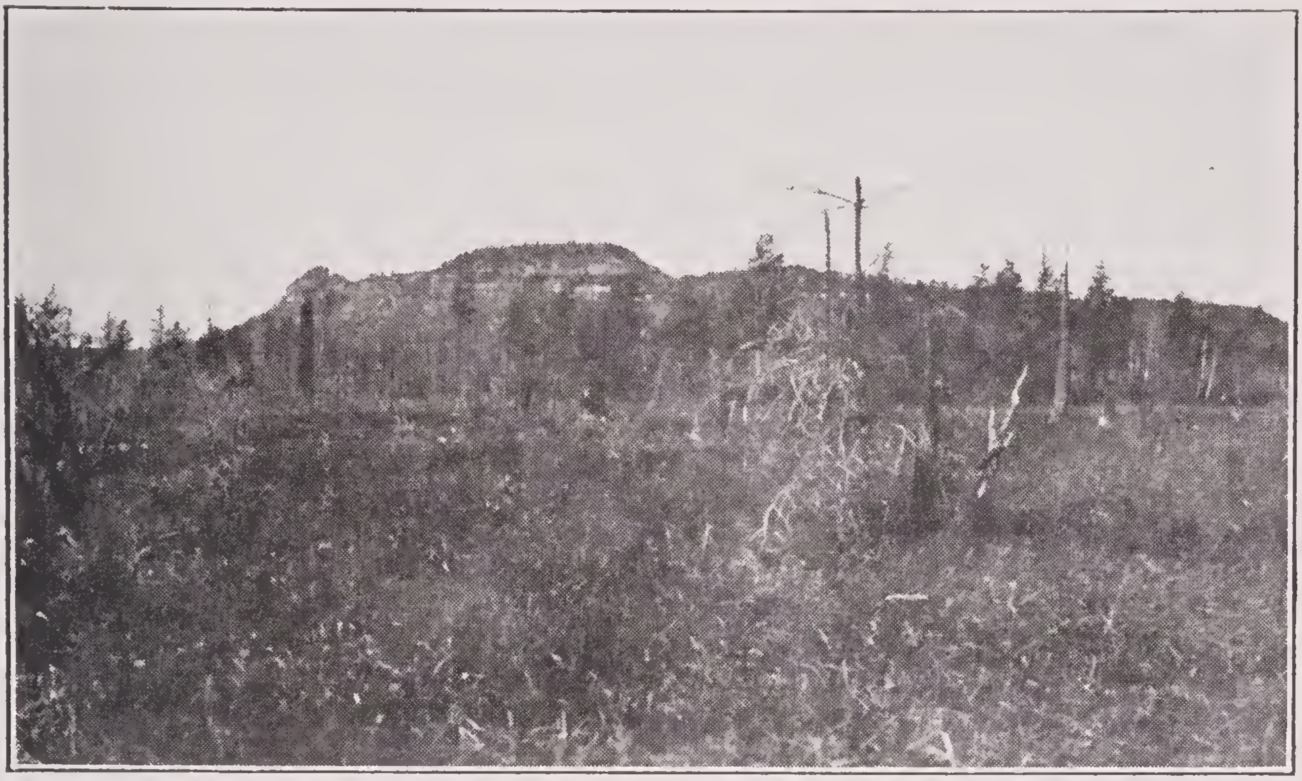
Description.—The surface soil of the Boone fine sandy loam to an average depth of eight to ten inches consists of a grayish-brown fine sandy loam, which in some places contains a considerable quantity of medium sand. The quantity of organic matter present is not large, and a slightly acid condition is found to exist over most of the type. The subsoil consists of a brown to yellowish-brown fine to medium sandy loam, which usually extends to a depth of over three feet.

Both soil and subsoil of this type are subject to considerable variation, though none of the variations are found of sufficient extent or importance to be mapped as a phase, except the more rolling tracts which are usually shallow.

Outcrops of sandstone are not uncommon, although they are not extensive and seldom interfere to any marked extent with cultivation. The depth to the underlying rock is variable, and while it averages over three feet, there are places on the tops of ridges and on knolls where there may be as little as two or three inches of soil. There are also places over gently rolling tracts where the soil has a depth of only two or three feet, but such areas are not extensive.

Topography and drainage.—This soil generally occupies the intermediate slopes lying between the high ridge lands and the sandy flats bordering some of the streams. The topography is generally gently undulating to rolling, some larger areas being nearly level, and some portions near the ridges and rough stony land having a fairly rolling surface.

Generally this soil withstands erosion well, both because the soil can absorb much water quickly and because the surface is generally not very rolling. In a few cases, erosion has gotten beyond control and bad ditches and ravines have been formed. Samples of these big ditches may be found along the Pine Hill Road two miles west of Shamrock.



View of Wildcat Mound. Sandstone ridges are included with the Rough Stony Land type. Black Dunning marsh border soil in foreground and Tamarack peat swamp in the rear, bordering mound.

Topography and vegetation typical of the Boone fine sandy loam. Sandstone ridge of Rough Stony Land in rear.

On account of the sandy character of the soil and the surface features, the natural drainage of this type is excellent. Where the soil is shallow and where the slopes are steep, the type frequently suffers from lack of sufficient moisture, though as a whole it retains moisture fairly well.

Origin.—The original Boone fine sandy loam is largely residual having been derived from the weathering of the Potsdam sandstone, and from a shaly phase of this formation. On some of the slopes, it is probable that some of the sandy material has been moved short distances down the slope by washing. Where there is silty material incorporated with the soil, it is probable that a part of this has been washed down from higher lying silt loam types. Thus it will be seen that the type may also be partly of colluvial origin, although this phase is of minor importance. In a few places, sand dumes have been formed, but these are also of small extent. The original timber growth consisted partly of black and scrub oak covering the shallow knolls and the lighter portions of type.

Native vegetation.—On the heavier portions there was some birch and maple. Sumac, hazel brush, poplar, and wild cherry form the second growth in uncultivated places.

Present agricultural development.—By far the greater proportion of the type is put to some form of agricultural use, and most of it is cultivated. The wooded portion is confined chiefly to the steeper slopes and shallow knolls, which are covered mainly with small oak. As is the case with the county as a whole, most of the type is devoted to general farming, with dairying as the most important branch. In connection with dairying quite a number of hogs are raised.

The chief crops grown and the ordinary yields are as follows: Corn, 40 to 50 bushels; oats, 30 to 40 bushels; barley, 35 to 40 bushels; and hay from one to two tons per acre. Some rye is also grown, and it gives fair yields. On some of the level portions of the type some farmers report an increasing difficulty in getting a good stand of clover. Others on the gently rolling phase report no trouble whatever, no clover having been lost in the last seven or eight years. Very fine stands of clover appear on some of the lighter portions of the type, even though the soil showed indications of acidity in response to the litmus paper test.

When the county was first settled, wheat was grown extensively on this soil, but very little is now produced. It is considered a fair corn soil, and the yields are practically the same as on the Knox silt loam. Potatoes can be grown successfully, though the acreage is not large.

The rotation of crops most commonly practiced consists of corn, followed by oats or barley, with which clover and timothy are seeded. Hay is cut for one or two years, and the field may be pastured for a year before being again plowed for corn. Cultivation of this soil is not difficult, and a lighter class of implements and stock can be used than on the silt loam type.

The selling price of land of this type is quite variable, depending upon location, character of the surface, texture of the soil, and improvements. In the most favorable locations, the gently sloping and nearly level portions of the type sell for sixty to one hundred dollars an acre. The rougher places which are more distantly removed from towns are held at twenty-five to fifty dollars an acre.

VESPER FINE SANDY LOAM

(Including Vesper Loam)

The Vesper fine sandy loam is an extensive type of soil. It lies in the east end of the county in a compact body three to five miles wide extending from the vicinity of Merrillan east to City Point.

The surface soil consists of six to ten inches of grayish-brown fine sandy loam. On some places, the surface one-half inch is dark brown or black due to more organic matter in it. The subsoil is a yellowish or mottled fine sandy loam or fine sand. At from twelve to thirty inches deep the subsoil becomes a stiff compact, mottled, or bluish sandy clay loam or clay. This tight clay layer varies from two to twelve inches in thickness beneath which again is found sand, sandstone or shale rock. The rock generally lies at about twenty-four inches beneath the slight knolls while on the flats and lower ground, the surface soil is generally somewhat sandier than usual, the clay layer thicker and the rock lies at greater depths.

The topography varies from flat to gently undulating. In a few places, bordering streams, the land is more rolling, but this condition is not at all extensive. The drainage of this soil is

deficient. Because of the heavy clay layer and the shale rock beneath it, the rain water cannot penetrate deeply into the soil. The result is a soggy, cold condition of the land till late in the season each spring. This is liable to be true even on gentle slopes. The drainage is better in a few instances on small knolls and bordering the stream courses, and these places are where crops are most successfully grown. The drainage of Sections 4, 5, 9, 19, 12, 14 (Township 22, Range 1 West) is better than the average as they border the East Fork of Black River.

The Vesper fine sandy loam is largely brush covered. The original white and Norway pine timber has all been removed and outside of a few oaks and Jack pine, there is very little large timber. Poplar, birch, Jack pine and oak brush cover most of the land. Willow, alder, moss, and sweet fern grow on the lower portions.

In origin this soil is largely residual from the underlying sandstone and shale.

Only a small proportion of the type is improved, and the land has a comparatively low selling value. By many it is considered as having limited possibilities, but demonstrations which have been made with the use of lime and with phosphate fertilizers seem to show that with drainage this soil can be made to produce profitable crops. Yields of corn of 60 bushels per acre are known to have been obtained.

For a discussion of the methods best suited for the improvement of this soil see page 36.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Vesper fine sandy loam:

Mechanical Analysis of Vesper Fine Sandy Loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
312809	Soil	0.2	2.2	4.4	65.8	11.8	11.2	4.3
312810	Subsurface	.4	1.4	4.3	69.7	11.7	8.8	3.8
312810a	Subsoil	.6	1.0	.8	16.1	21.7	29.0	30.9

CHEMICAL COMPOSITION AND FERTILITY OF THE MEDIUM HEAVY SOILS

These soils vary in the content of plant food as shown by the chemical analyses. In general the loams are better supplied with prosphorus and nitrogen than are the fine sandy loams. The latter possess about 1,500 to 1,700 pounds of nitrogen per acre eight inches deep while the loams have from 500 to 700 pounds more. The fine sandy loams show about 800 pounds of phosphorus while the loams have about 1,000 pounds an acre, eight inches.

Potassium is present in considerable amounts in all the soils, varying from 20,000 to 40,000 pounds an acre, eight inches. The acidity ranges from slight to strong.

The need for lime is most marked in the Vesper fine sandy loam and to a somewhat less degree in the Boone fine sandy loam. This group of soils is adapted to a variety of crops and with the exception of the Vesper fine sandy loam, which is naturally deficient in drainage they produce good crops of corn, potatoes, oats, alsike clover and timothy and some tobacco.

It is more difficult to keep up the content of organic matter in these soils than in the heavier silt loams. Lime will be needed on all of the types when alfalfa is to be grown and may be required to insure a good stand of clover. (See p. for discussion on liming.)

The use of acid phosphate will in most cases prove to be profitable. This applied broadcast to grain crop seeded to clover will not only increase the grain crop but will aid in insuring a good growth of clover or alfalfa which in turn will increase the organic matter and nitrogen content of the soil (For discussion of commercial fertilizer see page).

On the Vesper fine sandy loam tile drainage is needed since this soil is too wet much of the time for most crops to do well. Tiling is made more difficult by the presence of the blue shale clay and shale rock layers at varying depth in the subsoil. Knolls and rolling areas in this soil produce good crops.

In the improvement of the type drainage is the first step. The soil is low in organic matter and phosphorus and is in need of lime, but the supply of potassium is large and this high potassium content appears to be general. With proper drainage and fertilization together with the use of lime, this soil offers good opportunities for agricultural development.

CHAPTER IV

GROUP OF SANDY SOILS

BOONE FINE SAND

Extent and distribution.—The Boone fine sand is widely distributed over nearly all parts of Jackson county. It occurs wherever the loessial or wind-blown silty blanket of soil failed to cover the sandstone, or where the silt surface has since been removed by erosion. In the east half of the county this soil covers the greater part of the upland. In the western part this soil is confined largely to the valleys and slopes surrounding the sandstone ridges and outcrops. Pine, Low and Tank Creek valleys in the towns of Hixton and Albion have much of this soil.

Description.—The soil of the Boone fine sand, to an average depth of six inches, consists of a brown or yellowish fine sand, in the surface inch or two of which there is a very small amount of organic matter. The soil is loose and open, and is occasionally blown into small dunes by the wind. Sandstone fragments and some chert may occur upon the surface and be mixed with the soil. The subsoil consists of a fine yellow sand, which contains fragments of sandstone and chert, and usually grades into disintegrated sandstone or into the solid rock at two to ten feet. The texture may become coarser as the rock is approached. The underlying rock frequently outcrops. The depth to rock is variable and ranges from one foot to five or six feet. Where the depth is greatest, rock fragments are seldom found; where the soil is shallow, they may be very plentiful. As a rule, the soil is thinner in the hill country than in a flat region. The subsoil may have a reddish-brown color, but the type as a whole is quite uniform, and what variations occur are of minor importance.

Topography and drainage.—The topography of this soil varies from very gently sloping to rolling. On the larger areas of

the soil, the surface is undulating for the most part, the rolling topography occurring only in the vicinity of the sandstone mounds and ridges. Some of this soil is nearly level and in the east end of the county the areas of level topography are outlined as a level phase of the Boone fine sand. The level areas outlined occur mainly in the towns of Bear Bluff, Knapp and City Point.

The surface soil has in places been blown into low dunes. On account of the loose, open character of the soil and subsoil the natural drainage is excessive, and crops usually suffer from drought during a portion of every season. On account of the surface features and the loose, open character of both soil and subsoil, the natural drainage is excessive and the type is droughty. None of the slopes are sufficiently steep to make the prevention of erosion an important factor in the management of this soil.

Origin.—In origin the Boone fine sand is largely residual, having been derived from the weathering of Potsdam sandstone. There is but little organic matter present, and such a small quantity of silt and clay that the loose surface material is readily blown by the wind, and in a number of places low sand dunes have been formed. The material composing the type is in an acid condition, as indicated by the litmus paper test.

Native vegetation.—The original timber growth on this type consisted chiefly of Norway and Jack pine and scattered scrubby oak. Coarse grasses and sand burs are also found growing on the type, although there are a number of places where the surface is bare of vegetation, and the soil is now drifting.

Present agricultural development.—The Boone fine sand is one of the most extensive types of soil in Jackson County. While a large part of it occurring in the western part of the county with soils of greater agricultural value is used for some agricultural purpose, a very large part of the soil in the east half of the county is not cultivated. Large areas remain covered with brush. Bushes or small trees and portions once cultivated have been abandoned in many cases. Perhaps fifteen to twenty-five percent of this soil is cultivated or used for some agricultural purpose. The presence of better types of soil in the vicinity always encourages the cultivation of this soil, but where this

soil occurs exclusively in large areas, agriculture does not thrive notably on it.

Good yields of crops adapted to the soil are often produced in favorable seasons where the land is properly cultivated. Such crops as corn, rye, buckwheat, beans, cucumbers, tobacco and clover are grown on this soil in different parts of the county. Special crops succeed best on this soil because of its easy cultivation, but the land can be very quickly run down and crop yields greatly reduced where methods for keeping up the soil fertility are not used.

Dairy farming is at a disadvantage unless the stock can range over a large area of land, or in case the farm includes bottom land or heavy soil for pasturage, for this soil furnishes scant pasturage during the dry parts of the summer months.

Tobacco and beans are grown on this soil mainly in the valleys west of Black River in the towns of Springfield, Northfield, Albion, and Curran. Cucumbers are grown in the towns of Brockway, Alma, and Komensky.

The chief crops grown and the average yields obtained during the most favorable seasons are as follows: Corn, 15 to 20 bushels; oats, 15 to 20 bushels; rye, 12to 15 bushels; buckwheat, 10 to 12 bushels; and potatoes, 50 to 100 bushels per acre.

The yields of crops vary greatly on this soil, depending partly on the location of the land, the kind of season, and in part on how the land is handled. The best yields are generally obtained where this land lies in such a position that it does not dry out too readily in the summer months, such as on a north slope or at the base of a slope where run-off and seepage of the rainfall tend to keep the soil moist and still not too wet. Best yields are also obtained where small patches of this soil are surrounded on the farm by heavier soil. On such places, the farmer seems to have more manure to spare for the light soil, and he often has better success with clover. A slightly more compact subsoil than normal is sometimes found in such locations as described above.

Very good yields of mammoth clover are sometimes obtained on this soil, and in a number of places clover for seed is regularly grown. Some farmers find that spring sown clover with oats does better than with fall sown rye on this soil. In other locations where this soil is extensive, clover is practically never

grown and a good catch is very difficult to obtain. From $150 to $250 worth of tobacco an acre, from $100 to $150 worth of cucumbers, from eight to ten bushels of white beans, and from 90 to 125 bushels of potatoes are some of the yields of special crops reported in favorable seasons. The special crops are subject to frosts and total failures sometimes result from this cause as well as from dry weather. From one to three or four acres per farm is generally the limit of acreage where these special crops are grown, although on a few farms much larger acreages are grown.

The most successful farmers on this soil raise a small acreage of special crops and for general crops, they grow mainly rye, corn or buckwheat and generally are able to grown enough oats for their own use. In some cases a three year rotation of rye or oats with clover first year, hay and pasture second year, corn third year is practiced. Where clover is seldom if ever grown and farm manure is scarce a portion of the land is allowed to lie fallow about one year in three. Very little commercial fertilizer is used except by some of the cucumber growers. Tobacco fields are usually heavily manured and farm manure is the main fertilizer used.

BOONE FINE SAND

(*Poorly Drained Phase*)

In Sections 23, 26, 34, 35 in Town 22 North, range 3 W, three or four miles south of Hatfield, there is an area of several square miles of low lying upland soil which has rather poor drainage, and which is separated from the typical Boone fine sand as a poorly drained phase. This soil is somewhat variable, but in the main, consists of a rather dark, medium to fine sand with a subsoil which is yellow or sometimes mottled. There is no shallow or heavy layer of clay in the subsoil, although sandstone rock is sometimes found at three or four feet below the surface. In a few instances a small amount of sticky material was found in the lower depths.

A part of this land is cultivated and gives fair yields, especially during the drier years.

There is another small area of this type lying in Sections 13 and 24 about one and one-half miles east of Black River Falls. A considerable portion of this area is also under cultivation,

and in improved farm land. Over both of these tracts, the surface is level to very slightly undulating. On the slight elevations, the surface is lighter colored and better drained than the lower areas. During wet years there is sometimes an excess of moisture, but during dry season, this soil is much better supplied with moisture than the typical Boone fine sand. Because of this condition and the presence of clay in deep subsoil, this phase is considered to be a better soil than the typical Boone fine sand, and one which is capable of being more highly improved.

PLAINFIELD SAND

Extent and distribution.—The Plainfield sand is located on flat-topped benches or terraces which rise abruptly from the Black River, and extend back to the high bluff land on either side. In places there are several levels or steps of from fifteen to forty feet elevation each up from the river bottom to the land of the highest terrace on which the residence portion of the city of Black River Falls stands. This terrace level extends several miles eastward along Morrison and Levis Creeks and narrows again to a narrow bench above Hatfield in Clark county. In the southern end of the county, only narrow strips of this soil are found in or bordering the river bottom. Narrow strips of this soil are found in Trempealeau and Beef River valleys also.

Description.—The typical soil of the Plainfield sand consists of a yellowish-brown sand of medium texture extending to an average depth of eight to ten inches. The structure of the soil is loose and open, and there is present a considerable amount of iron, which gives the rusty color and a slight loaminess in places. It also carries a small amount of organic matter, but the color indicates a higher content than actually exists. A little gravel is seen upon the surface in some places, and a small amount of fine gravel is mixed with the soil. The subsoil consists of a yellow medium sand, which usually becomes coarser in texture with increased depth. The subsoil always contains more gravel than the surface soil. Where the subsoil contains considerable iron, as is the case in spots where the drainage has been impeded for any reason, the material has a brownish or sometimes a reddish color, but this usually fades as the depth increases.

Topography and drainage.—The topography of this soil is level, the only variations being where streams have cut across the terraces to the river bottom or at the abrupt rises from one terrace level to another. Where specially marked, the terrace intervals are indicated by cross-lining over the color representing this soil.

Because of its generally loose and open character and the porous condition of the subsoil, this soil is generally well drained, and water passes through it so readily that crops are liable to suffer for lack of water in any spell of dry weather.

Present agricultural development.—This soil is an extensive type in the central part of the county. Large parts of it remain uncultivated. The cultivated portion is occupied largely by Polish people or Indians who cultivate small tracts. The vegetation of the uncultivated portions consists of small scrubby oak, Jack and Norway pine, poplar, birch, oak, cherry. Sweet fern and blueberry brush cover the ground.

From twenty to thirty per cent of the type has been cleared and cultivated at one time, but a considerable number of farms have been abandoned, and no crops are being grown upon them at the present time. The chief crops grown at the present time and the yields secured during the most favorable years are as follows: Corn, 15 to 25 bushels; oats, 20 to 25 bushels; buckwheat, 12 to 16 bushels; and potatoes, 100 to 150 bushels per acre. Potatoes form the chief cash crop, and do better than any of the other crops grown.

In a few cases white beans are grown on this soil, and the yield is as high as ten bushels per acre in favorable seasons. Cucumbers are grown to some extent in the vicinity of Hatfield. The yields of all crops vary greatly with character of the season, and the treatment given the soil. Under most favorable conditions, very fair yields of clover and of mixed alsike clover and rye hay are obtained; frequently fair corn is grown. But the failures of crops are frequent on this soil, and because of the poor pasture afforded, this soil is not well adapted to dairy or general farming.

Some of the Polish farmers maintain a considerable number of young stock by grazing them over large areas of this brushy undeveloped soil, and on the flat shallow marshes which lie at the borders of this type of soil. It is very difficult, however,

View showing the topography and vegetation conditions in the sand and marsh country in the east end of Jackson county. Marsh grass in the foreground, willows and tamarack clump in background.

VIEW OF CORN ON PLAINFIELD SAND.

This shows about an average crop where no fertilizers have been used. The stand was fair but the corn was short, and the yield low.

to raise enough feed on this soil to keep any considerable number of cattle through the long winters.

Land is very cheap on most of this soil type. From six to fifteen dollars an acre represents the selling price of much of it. In the Trempealeau and Beef River valleys the soil is somewhat higher priced due to the presence of better soils in the vicinity.

PLAINFIELD FINE SAND

Extent and distribution.—This soil is practically all confined to the areas bordering Robinson Creek in the townships of Manchester and Millston. Like the Plainfield sand, this soil occupies the highest terrace level along the Black River valley and extends back in a practically level plane eastward to Millston. The texture of the soil seems to be slightly coarser at the east end than at the west end of the area, but no definite boundary can well be established as the change is not uniform nor distinct.

Description.—The surface soil of the Plainfield fine sand consists of a brownish-gray or yellowish loose fine sand extending to a depth of about eight inches. The surface two inches contains more organic matter, making it a brown or dark brown in its virgin state. This is underlain by a yellow loose, fine sand which extends to a depth below the reach of the soil auger. In texture, structure, and color this type is quite similar to the Boone fine sand, but differs from that type in origin and topography. Like the Boone fine sand, it contains only a very small quantity of organic matter, and is in an acid condition.

Native vegetation.—Only a small part of this soil is under cultivation, the farms on it being confined to a small group near Shamrock, near Millston, and at the Sandy Plains School in the center of the area. The great majority of the soil is covered with a second growth of Jack and Norway Pines, oak, poplar, white birch, and hazel brush. A few large white pines in the vicinity of Millston are the only remnants of an original Norway and White Pine forest covering the area.

Present agricultural development.—There are only a few farms under regular cultivation on this soil, and the farming is not of a very progressive kind. The farms are small and considerable parts of the cleared area lie fallow or abandoned where once cultivated. The crops grown consist of rye, corn,

buckwheat, and potatoes. Where grass marshes and stream bottom land adjoin this soil, it is possible to keep young stock and a few dairy cows. The soil is subject to drought, and does not support a good quality of pasture when dry spells occur in the summer season.

In favorable seasons on new ground corn yields 20 to 25 bushels, rye 15 bushels, oats 20 bushels. Beans and cucumbers are grown by some of the farmers. The raising of special cash crops is limited because of the hauling distance to the railroad and the sandy roads. Potatoes yield 100 to 125 bushels. Wild land sells for from five to ten dollars an acre; improved land for from twenty to twenty-five dollars.

PLAINFIELD SANDY LOAM

The Plainfield sandy loam is a brown sandy loam sixteen to eighteen inches deep, resting on a subsoil which becomes lighter in color, and if anything a little lighter in texture with depth, and passes usually at about thirty inches into a yellowish sand. The lower part of the soil section thus resembles that of the Plainfield sand.

In Squaw Creek Valley this soil is reddish or chocolate-colored in places, indicating the presence of a great deal of iron due to a formerly poorly drained condition. This soil is not an extensive one. It is associated with the Plainfield sand soil, and includes several small areas bordering the river bottom or tributary streams south of Black River Falls.

This type has the same origin as the Plainfield types, and also supports about the same scrubby growth.

From an agricultural standpoint, it is somewhat better than the sand type, but yields are lower, and special care is needed in cultivating and fertilizing this type.

VESPER SANDY LOAM

This soil is mapped chiefly south and east of Merrillan, and covers a total of about three square miles of area.

The surface soil is variable, running from a fine sand and sandy loam to a sticky, clayey sandy loam. The subsoil at six to twenty-four inches is a mottled or bluish clay loam, containing sandstones or shale fragments of small size. In some cases,

white sand or sandstone rock lies at thirty to thirty-six inches, but generally the soil is over three feet deep.

The topography is nearly level and the drainage is often deficient both because of the level topography and the impervious subsoil. Where the surface soil is more sandy, and the subsoil clay layer lies at twenty-four to thirty inches or below this soil is not too wet to raise fair crops. Several small clearings are cutivated and corn, beans, potatoes, and rye are grown.

Most of the soil is uncleared, and the vegetation consists of oak, poplar, jack pine, and willow brush. Moss and leather leaf cover the surface of the ground.

CHEMICAL COMPOSITION AND FERTILITY OF SANDY SOILS

The sandy soils are generally lower in content of phosphorus and nitrogen than the heavier soils. The fine sands and sandy loams are somewhat better supplied than the sands. Per acre, eight inches of soil, the sands have from 900 to 1,000 pounds of nitrogen, and about four hundred pounds of phosphorus, while the fine sands and sandy loams have from 1,400 to 1,600 pounds of nitrogen, and five hundred to eight hundred pounds of phosphorus. The potassium amounts to from twenty to twenty-five thousand pounds per acre.

In some respects sandy soils have advantages over heavier soils. They become drier and therefore warmer and can be worked earlier in the spring and more quickly after rains than heavier soils. These advantages are particularly important in regions of short growing periods. But when the soil is too sandy it does not hold sufficient water from one rainfall to another to satisfy the needs of the growing crops and it therefore suffers from drought. Moreover, some sandy soils are lower in their supply of the chemical elements demanded by crops than heavier soils. When these two factors become too low they limit the profitable farming of these soils. In the mapping of the Soil Survey those soils which are classed as sandy loams have fairly good water holding capacity, and when their fertility is properly maintained their good qualities in regard to warmth and earliness can be taken advantage of and they can be farmed with profit. But soils which are classified as sands and some of the fine sands do not have sufficient water

holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grain. The chief factor limiting their agricultural use is that of water holding capacity. This depends chiefly on the texture or fineness of grain and can not be affected by any treatment it is practicable to give them. The water holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparatively slow process and the amount of organic matter it is practicable to develop and maintain in these soils will increase their water holding capacity only to a limited extent.

When a sufficient supply of active organic matter is developed in these soils more of the phosphorus and potassium will undoubtedly be made available, but the use of fertilizers containing these elements in a more readily available form is desirable whenever these soils are farmed.

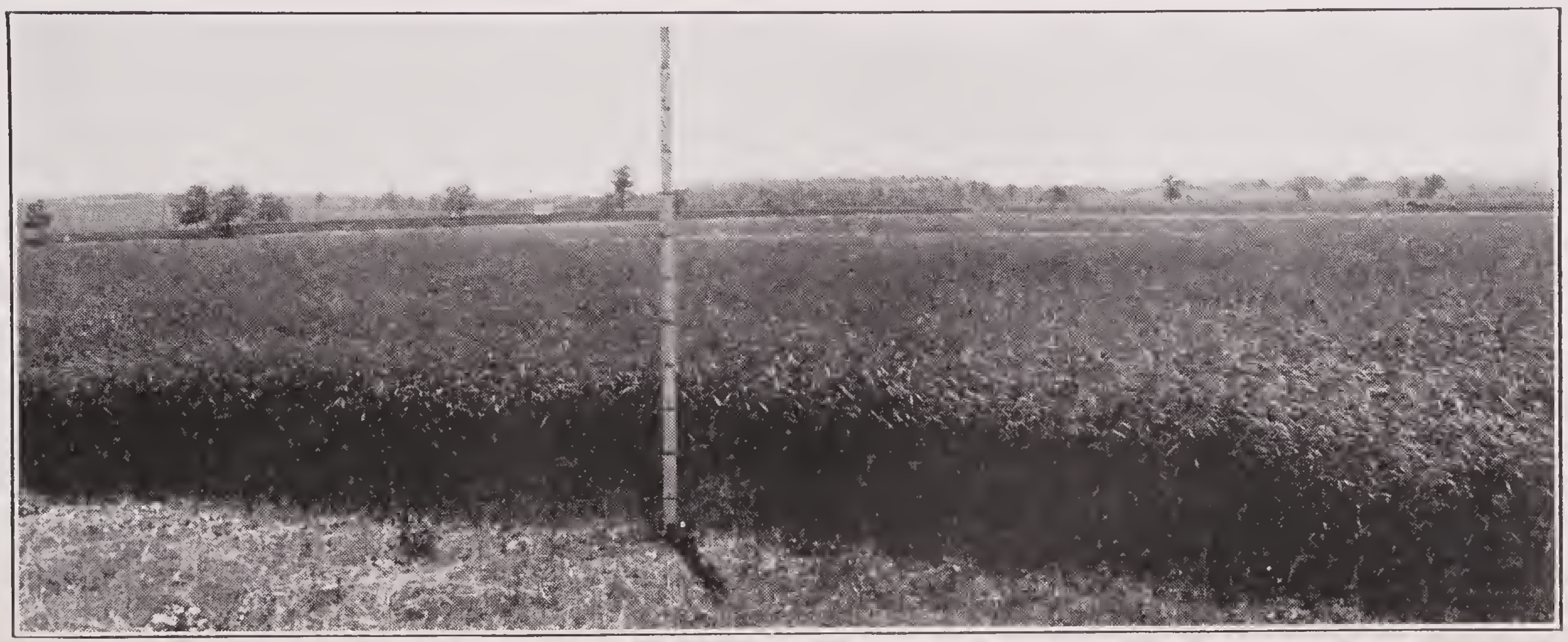
The starting point in the improvement of these soils is the development of active organic matter through the growth of legumes which are able to secure their nitrogen supply from the atmosphere. But before legumes can be grown with the greatest success the liming of the soil is necessary. The growth of a good crop of mammoth clover or soybeans through the use of lime and mineral fertilizers containing phosphorus and potassium is the best means of supplying this nitrogen and organic matter. In most cases this legume should be plowed under as a green manuring crop.

Probably the best way to get clover started is to seed with a small grain. By using a light seeding of rye, disked or harrowed in and seeded to clover in the spring, a good stand can usually be secured. The seed should be put in a little deeper than on heavy soils, and the drill should be followed by a corrugated roller, or if this implement is not at hand, an ordinary roller, followed by a light harrow should be used. When clover is seeded with a small grain in this way the growing grain helps to hold the soil in place and prevent blowing of the loose soil by the wind.

As the result of careful experiments on extremely sandy soils it appears that the best crop rotation for this class of land

CLOVER GROWING SUCCESSFULLY ON PLAINFIELD SAND.

The rotation followed on this field is corn, rye and clover. Plot on right received 8 tons manure and 400 pounds rock phosphate applied to the corn crop. There was no other fertilization during the rotation. Plot on left had no treatment.



FIELD OF RYE ON PLAINFIELD SAND AT HANCOCK, WISCONSIN.

consists of rye, clover, and corn. If the fertility is extremely low, it will be advisable to plow under the entire clover crop. If the fertility is fair the first crop may be cut for hay and the second plowed under. While potatoes are quite extensively grown on these extremely sandy soils this crop is not as well adapted to the sand soils as to sandy loam types. It has been shown by actual field tests that the yields of corn, for example, can be more readily increased on the sand soil than can the yield of potatoes. The potato when grown on sand soils does not respond to methods of soil improvement as readily as when grown on soils which contain somewhat more silt and clay. The sandy loams and fine sands and fine sandy loams are much better adapted to potato culture than are the sand soils. It is therefore advisable to reduce, where possible, the acreage of potatoes on sand soils.

With an increased acreage of corn it will be possible to put up enough silage so silage may be used for summer feeding. With this practice less pasture will be required, and this again will be desirable since the sand soils do not supply good grazing, and are not well adapted to any of the grasses. This system would make possible keeping more stock, and with the increased supply of manure the fertility of the land could be more readily maintained.

When properly managed alfalfa can be successfully grown on very sandy soils. For further information on the management of soils, see Bul. 299, Wis. Exp. Sta.

CHAPTER V

GROUP OF SOILS LACKING GOOD DRAINAGE

DUNNING SAND

Extent and distribution.—The Dunning sand is confined to the sandy portion of the county east of Black River, and in mapping, it was frequently made to include some of the land lying between the marshes and the Boone fine sand. The soil is not all black and not all distinctly flat marsh border land. Small areas of higher land where the drainage is poor, and where grass swales and depressions are too numerous to separate, were included in this type.

Description.—The surface soil of the Dunning sand consists of brown to nearly black, medium, or fine sand six to twelve inches deep, containing a high percentage of organic matter, which imparts to the soil its dark color. The subsoil consists of a grayish or whitish fine to medium sand, which has a leached or washed appearance, and extends to a depth beyond three feet. In places, the subsoil is stained by iron oxide and bluish mottling is not uncommon. The depth of the surface soil varies, but in other particulars the type is uniform.

Topography and drainage.—The surface of the soil is always low and generally level. It is very little higher than the level of the marshes and slightly lower than the bordering sands of light color. On account of its low position and the nearness of the water table to the surface, the natural drainage is poor, and as a result the type is too wet for ordinary farm crops, except during the dry portion of the summer.

This type of soil is an extensive one in connection with the sand and marsh country of the east half of the county. Agriculturally it is not important as the soil is generally too wet to raise crops, and very little of it is under cultivation.

Origin.—The Potsdam sandstone is the parent rock from which the Dunning sand was derived. It has been reworked, trans-

ported, and deposited by the action of the water, but to what extent, it is impossible to say. Under moist conditions, it has acquired a black color through the growth and decay of vegetation. The whitish color of the subsoil may be due to the leaching of organic acids. All of the soil is in a very acid condition at the present time.

Native vegetation.—The native vegetation consists of Jack pine, poplar, sweet fern, common ferns, mosses, blue stem, and several species of marsh grass. There is no timber of any value on the type at the present time.

Present agricultural development.—As the type is low, poorly drained, and acid, it is not cultivated except in a few places. It is devoted chiefly to the production of wild marsh hay and to pasture. Where cultivated corn and buckwheat are the crops most grown. One farmer reported a yield of forty bushels of corn, and 150 bushels of potatoes per acre. Before this type can be farmed extensively, it must be drained, properly fertilized and limed.

This soil has low natural fertility, but when properly drained, limed and treated with stable manure or phosphate and potash fertilizers it can be made to produce good yields of potatoes, corn, oats, rye and clover.

For a discussion of the use of lime and commercial fertilizers see pages 71 and 73.

GENESEE FINE SANDY LOAM

The Genesee fine sandy loam occupies a large part of the bottom lands along the Black River. The soil occupies the same level as the Genesee silt loam, but usually lies on slight elevations from one to four or five feet above the silt loam. The soil is quite variable due to its manner of deposit and occasional overflow. The surface soil varies from a very fine sand to a heavy fine sandy loam or loam. The subsoil is generally more sandy than the surface. The color varies also from light brown to a chocolate or reddish-brown.

This soil also is in large part timbered or brush covered bottom land, but natural open areas or cleared portions are under cultivation. Generally occupying slightly higher elevations than the Genesee silt loam, it is not affected by the smaller floods so that during many seasons, portions of this soil can be culti-

vated. Good crops of corn, oats, and potatoes can be grown. This land cannot well be permanently improved and protected from floods, however, so that its agricultural value is comparatively low.

GENESEE FINE SAND

This type includes several small areas of low-lying fine sand soil on the first bottom land bordering the Black River south of Melrose. The type is not extensive and because of its being subject to frequent overflow, its agricultural value is low. Its use is confined to pasture and wood lot purposes.

GENESEE SILT LOAM

The Genesee silt loam occurs as first bottom land along the larger streams, and is subject to occasional overflow from the streams. The soil is generally a grayish or drab silt loam with a compact mottled or iron stained silty clay loam subsoil. Sometimes the surface two or three inches of soil has a dark brown or black color due to greater amounts of organic matter in it.

The greatest amount of this soil occurs in the overflow lands bordering the Black River from the city of Black River Falls southward. Some was mapped along the Trempealeau River and tributaries. The soil is a grayish-brown heavy silt loam with a mottled iron-stained heavy silty clay subsoil. Variations from this description occur where slight knolls of very fine sandy loam occur, or sandy streaks along abandoned slough banks and water courses.

In Sections 4 and 9 (Township 20, Range 4 West), this soil lies on different levels and portions of it less subject to overflow are cultivated. Grass and willow swales occur in the higher levels where the soil is springy and wet.

The greater part of the Genesee silt loam bottoms are timbered or brush-covered. The trees consist of large elms, ash, soft maple, birch, and willow. In a few places, open areas occur where the vegetation is mainly grass or small brush.

The land is used largely for pasture land and wood lots. Some of the higher levels of small extent could be improved by tiling, but most of the soil is too low and subject to too much overflow to be profitably drained.

WABASH LOAM

This soil is also of alluvial origin, and being situated in the valley bottoms bordering the streams, and subject to more or less overflow, the texture of the soil is not very uniform.

The surface soil of these bottoms is generally a dark brown, drab or black loam or silt loam with a generally heavy mottled clay loam subsoil which, however, may have sandy layers in it. The surface soil also may be strewn with sand, gravel, stones, etc., and sandy layers may be encountered at any depth within the soil section.

The Wabash loam is found in a number of valley bottoms scattered through the west half of the county. The soil type is not extensive, as it comprises narrow strips of bottom land only. Very little of the land is under cultivation, most of it being generally too low and wet. It is, however, almost entirely used for pasture as the soil occurs on the bottoms of the narrow valleys whose slopes are also often used for pasture.

WABASH SILT LOAM

The Wabash silt loam consists of alluvial deposits, chiefly along the upland streams. The areas are quite narrow, varying from strips too small to map up to areas one-half mile or so wide. Because of its stream deposition in narrow bands and the meandering of the streams, it is not very uniform. Generally it consists of a grayish or light-brown silt loam to about eighteen inches, below which as far as the auger will reach occurs a black, mucky, silty loam. In certain places, however, these conditions may be reversed.

A variation from the general black or drab color of this soil is found along the Trempealeau River bottom near Taylor. There the surface soil is reddish-brown or chocolate colored due to large amounts of iron in it. There is a quite general layer of spongy bog iron ore lying at from three to eighteen inches beneath the surface soil in this latter area. This hard, chunky, or gravelly layer is six to eight inches thick, and is underlaid by sand or mottled or reddish sandy clay loam.

The Wabash silt loam is widely distributed in the valley bottoms of the west half of the county. This soil because of its low position is not generally under cultivation.

Much of this type has poor drainage and a good deal of it is subject to one or more overflows each year, and consequently cannot be depended upon for cultivation.

This soil is mostly of alluvial origin. The dark color is due to accumulations of organic matter from decaying vegetation, the growth of which was favored by moist conditions. Where there is a covering of light-colored material over the dark soil, this covering is often colluvial in origin, having been washed down from the adjoining slopes.

This soil is used almost exclusively for pasture and hay land for which it is especially valuable. Occasionally a fairly well drained patch is cropped, corn doing especially well on it, yields of 75 to 90 bushels per acre being reported. Hay will yield from two to three tons per acre. Owing to the narrowness of most of the areas and the low position of the land, it is doubtful if much of this type could be successfully drained. Some of the broader expanses where there is sufficient slope could be much improved by installing tile drains.

CHAPTER VI

MISCELLANEOUS SOILS

PEAT

(*Including the Shallow Phase*)

Description.—The material classified as peat consists chiefly of decaying vegetable matter in varying stages of decomposition, with which there is mixed a small but varying amount of mineral matter or fine earth. In color the peat varies from a brown to black. The depth of the material forming this type is also extremely variable, and on the soil map has been grouped into two phases. The typical peat is over 18 inches deep and may be as great as 15 feet, although the average would probably be 4 or 5 feet. The shallow phase of peat varies from 6 or 8 inches to 18 inches in depth. Usually the shallow peat is more thoroughly decayed and when this is the case it is of a darker color. The earthy subsoil under most of the peat consists of fine sand.

The color of the peat and the extent to which the vegetable matter has decayed are also variable, and these variations are of importance, although they have not been indicated upon the soil map, except as they are brought out by the differences in depth of the peaty material. By far the greater proportion of the deep peat, including the large tracts in the eastern part of the county, is brown in color having a raw, fibrous structure, showing that it has not reached an advanced stage of decomposition. It has about the color of fine-cut tobacco and it is so raw, fibrous or stringy that in many cases the stems, leaves and grasses or moss from which it is formed can still be recognized. This raw condition often extends to depths of from 3 to 6 or more feet, but usually the lower depths are somewhat more thoroughly decayed and of a darker color than the surface. As a whole, the peat of the shallow phase is somewhat more decayed and of a darker color than the deep peat, and in a few places, because of the larger content of fine earth approaches

a muck in composition. Such dark colored areas, which are well decomposed, however, are of rather limited extent.

As indicated above, the earthy subsoil under the Peat consists for the most part of a white or grayish fine sand. There are two exceptions to this which are worthy of note. The peat areas which are associated with and border the Vesper fine sandy loam in the northeastern part of the county, are frequently underlain by clay or shale the same as that which forms the subsoil of the Vesper types. These peat areas are of limited extent and form only a small proportion of the total area of peat in the county. The other exception is found in the western part of the county where there are small areas of peat land along the bottoms of some of the drainage ways where the surrounding uplands are heavy. In these places the subsoil of the peat is frequently heavy in character, but here also this variation is very limited in extent. In general it may be said that the heavy subsoil is confined chiefly to regions where the subsoil of the adjoining upland types is also heavy, but in such places the subsoil is not uniformly heavy. This soil map does not show this variation in the subsoil, because of its limited extent.

Extent and distribution.—Peat is the third most extensive type of land in Jackson county. It covers 15.7 per cent of the area or slightly more than 100,000 acres. Of this amount about 90 per cent is deep peat and about 10 per cent is shallow peat. The peat is more extensive in the eastern half than elsewhere. In the towns of City Point and Bear Bluff there ar over 60 square miles of continuous marsh land in this county with more of the same type of land in the adjoining parts of Wood and Juneau counties. In the eastern portion of the county the peat is closely associated with extensive sand areas of the Boone and Plainfield series and with the Dunning soils which are marsh border types. In the western portion the peat is found as long narrow strips along the drainage ways. The shallow peat is mostly found around the margins of the large marshes and as small patches associated with the marsh border soils. It may be considered as a gradation type between the Dunning soils on the one hand and the deep peat on the other.

Topography and drainage.—The tracts of peat soil are all relatively low, flat, and naturally very poorly drained. On many of the marshes water stands on the surface during the

spring and early summer. In this soggy condition the land is often so soft that it will not support the weight of stock. During the late summer, especially during dry seasons the marshes dry out so that farm stock can safely go almost anywhere, and the peat frequently becomes so dry that the danger from fires is something which must be considered. When fire once gets started in the peat it is very difficult to extinguish, and sometimes continues to burn until stopped by the fall rains. Practically all of the material mapped as peat is sufficiently high in organic matter so that it will burn when dry.

A number of large drainage ditches have been extended into and through the large marsh tracts, but these only supply partial outlets and in order to have the land sufficiently drained for the safe cultivation of crops numerous lateral ditches supplemented with tile drains are necessary. In the vicinity of cranberry marshes the drainage is restricted by the dams which form reservoirs for storing water so that the cranberries may be flooded when necessary. Outside of the cranberry marshes only very few lateral ditches have been installed, so that on but few if any tracts are the peat lands properly and sufficiently drained. From work already done there appears to be sufficient fall so that from an engineering standpoint it would be possible and profitable to drain all of the peat land in this county.

Native vegetation.—The present timber growth on the peat marshes consists of tamarack, alder, poplar, willows, and various other water loving trees. Only a comparatively small proportion of the peat marshes are timbered, most of them being open and treeless or nearly so. The open marshes support a growth of coarse marsh grass, wire grass or sphagnum moss, through which are scattered a small and stunted growth of water loving shrubs. Some of the grass marshes are pastured or cut for hay. The moss and trees are usually found on the wettest parts of the marsh while the grasses are most common on the parts of the marsh land which are better drained.

Present agricultural development.—While peat is an extensive type in Jackson county it is at present of limited importance agriculturally. Some cultivation is being attempted at several points, notably on Trowe's Marsh 5 and 6 miles northwest from Millston, on the Ring Marsh in Sec. 24 T. 21 N., R 2 W., and on the Albright Marsh in Sec. 30 and 31 T. 20 N.,

R. 1 E. In most of these attempts work has been done on a rather large scale, tractors sometimes being used. In most cases it has been found that due to insufficient laterals or tile ditches the drainage is not adequate and crop failures have resulted because of an excess of moisture, and on land which during a series of dry seasons produced fair to good crops of timothy hay. Commercial fertilizers and lime although needed, are not used to any marked extent on the marshes now being cultivated.

The crops most commonly grown here on the peat are buckwheat, rye, timothy, potatoes, root crops with some cabbage and onions on a small scale. Some attempts are being made to grow corn but because of the danger of summer frosts this crop is very uncertain. These marshes can not be considered as being in the corn belt.

Various sized tracts of the peat lands are being utilized to a limited extent for pasture and hay, although the wild marsh grasses have a low feeding value. These marshes are frequently burnt over to destroy the dead grass and trash upon the surface, and a fair stand of clean grass usually follows. While this is young and tender it makes fair pasture. If the marshes are burnt off during dry seasons there is danger of the peat itself being burnt.

Without fertilization the yields of the crops mentioned when grown on raw brown, fibrous peat are usually low and unsatisfactory. Where the peat is well decayed and of a black color fair crops may be secured for a few years without fertilization, but the readily available mineral plant foods soon become exhausted, when fertilization becomes essential. Where the surface few inches of the peat have been burnt there is a concentration of the mineral elements sufficient in some cases to insure two or three fair crops but when this is used up fertilization is again necessary. The fire, if not controlled, however, may prove to be a damage rather than a benefit, for deep holes may be formed, and the surface of the ground lowered to such an extent that the land will no longer be sufficiently drained.

In some places an industry of limited importance has developed in the cutting of wire grass which is cured like hay, baled, and sold to the manufacturers of grass rugs.

Frosts on marsh land.—It is well known that frosts frequently occur on marsh land where there is no frost on higher

land. This is partly because the cold air which forms on the surface of all the ground at night tends to flow down and collect in low places, but it is also the result of the fact that the loose, spongy soil of peat marshes does not conduct the heat received from the sun during the day downward. In consequence of this, the lower layers of soil do not become warmed in peat marshes as they do in other earthy soils and the little heat left in the surface inch or two of soil is rapidly lost at night by radiation, so that the freezing point is frequently reached on such soil when it would not be on more earthy soils such as sandy loam or clay loam which would conduct the heat downward better during the day and so keep warm farther into the night.

This difficulty with peat marshes can be overcome to a certain extent by heavy rolling which, by compacting the soil, permits the heat to be conducted downward more readily. It will also to a certain extent become less in time, as the peat decomposes and takes on more of the character of muck. Nevertheless, it must always be expected that marsh land will be more subject to late spring frosts and early fall frosts than high land. It may be stated as a general guide, that the occurrence of killing frosts is as liable on marsh land at any given point as it is on upland soil having good air drainage about 150 miles farther north; in other words, the marshes of Dane county are as liable to have a frost which will kill corn as early as are the upland regions of Shawano, Marathon, or Clark counties. The marsh land regions of Jackson county are liable to have frost two weeks or more earlier than the hill tops of the same latitude. This means that corn and potatoes, while safe crops for the upland region, are not safe crops for the marsh land and should not be depended on as the chief crops.

CHEMICAL COMPOSITION AND FERTILITY OF PEAT

The chief difference between peat soils and upland soils consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorus in the peats in this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot

there is approximately only 675 pounds, or in two feet 1,350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in a non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average 0.3 per cent of this element, while good upland clay loam soils average two per cent, or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3,000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent and this only in the surface eight inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and potassium. These elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat, the manure should be used on the upland soils and commercial fertilizers containing phosphorus and potassium used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

Crops and system of farming on marsh lands.—Since the growth of corn and potatoes to which these marsh lands would

otherwise be well adapted, is limited in this section on account of the danger from frost, the best staple crops for this land are grasses for hay and pasture, hardy root crops, and rye, and to a less extent oats. When properly fertilized and limed, clover, alfalfa, and other legumes can also be grown. On fairly well drained marsh land well decomposed good pasture can also be developed. The compacting of the soil resulting from the use of this land as pasture is also a great benefit to it. When peat land is placed under cultivation a heavy roller should be classed along with implements necessary to its successful management.

Where good pasture can be secured and other conditions are the most favorable, selected portions of these marshes can be successfully utilized for dairying or stock raising.

Certain special crops, such as cabbage, onions, buckwheat, sugar beets, and rape, are adapted to such lands when well drained and properly fertilized.*

Summarizing the peat situation for the future agricultural development of the peat lands such as are found in Jackson county it may be suggested that before farming on these lands can be permanently successful there are several conditions with which it is necessary to comply.

1. It is absolutely necessary that the land should be sufficiently drained. Large outlet ditches in themselves while necessary are not sufficient, and these must be supplemented with open laterals and tile drains before adequate drainage is insured.

2. This type of land is low in potash, phosphorus and often in lime and these materials must be supplied in proper form and proper amounts before permanent, profitable production can be expected.

3. It must be recognized that the danger from summer frosts make such crops as corn and potatoes uncertain, and the crops to be grown must be those which are not only suited to the soil, but also to the climatic conditions.

4. Those purchasing this type of land must not only see their way clear to pay for the land itself, but they must also provide adequate drainage and fertilization, both of which call for an added investment.

*For more complete discussion of the management of marsh soils see bulletin on this subject by the Agricultural Experiment Station.

5. The use of a heavy roller to compact the soil is a practical necessity in the cultivation of Peat lands.

It is suggested for those who desire to undertake the development of a Peat farm, in any region but have never had experience with this type of land, that it would be a good plan to rent such a farm for a year or two or possibly serve an apprenticeship on some successful peat farm. This would make possible getting valuable experience without making a large investment.

ROUGH STONY LAND

Rough stony land includes rock exposures, cliffs, and land which is too steep and rough to plow or cultivate. It may be considered non-agricultural, as it is of value only for the small amount of timber and pasture it supplies.

This type occupies a large part of the steep walls bordering the valleys and forms a border between the valley bottoms and the high land of the ridges. The type is developed as narrow bands many miles in extent, winding in and out of the valleys and coves, but confined to the steep slopes. A part of the type occurs as narrow ridges upon which areas of soil too small to be mapped are sometimes found. The bluffs and cliffs are highest along the western border of the county, and frequently reach an elevation of two to three hundred feet above the valley bottoms along the sides of which they occur. The ridge tops are also wider here than elsewhere, and range in width from one-quarter to one-half of a mile. The elevation of the ridge tops range from one hundred and fifty to two hundred feet above the valley floor throughout most of the interior of the western part of the county.

The rough stony land type also includes isolated mounds, hills, and ridges of sandstone rocks rising above the comparatively level plane of the eastern part of the county. None of these rough stony areas, such as Saddle Mound, Bruces Mound, or Stanley Mounds have any tillable land on their summits.

Rough stony land is quite uniformly distributed throughout the western portion of the county and is intimately associated with Knox silt loam, the steep phase of this type, and also with some of the Boone types. The greater portion of the rock consists of the Potsdam sandstone, although there is also some granite rock exposed along the bed of the Black River.

The forest growth still remaining consists of white oak, red oak, pine, hickory and a considerable amount of undergrowth and brush in places. The best timber has all been removed and what now remains serves to protect the slopes from washing.

The inclusion of rough stony land in farms reduces the value of better land and it renders the fields on or over the ridges less accessible. It makes hauling to market more difficult, as some of the roads cross steep strips of this class of land.

CHAPTER VII

AGRICULTURE OF JACKSON COUNTY

TYPES OF FARMING

At the present time, the agriculture of the west half of the county is partly general, and partly dairying with grain raising predominating in certain portions. There appears however to be a gradual reduction in grain raising in favor of dairying and general farming. There are several reasons why this portion of the county is best suited to dairying, and chief of these is that all of the land can be utilized to better advantage. When grain growing is followed exclusively it is impossible to fully utilize the steep rocky slopes, but when dairying is followed these slopes are made use of for they supply good grazing. Thus the smooth land and more gentle slopes can be used for growing winter feed for the stock, and the pasture, which is a very important item to the dairymen, is provided by land which in a grain growing program would not be utilized. Another factor favoring dairying in this region is that the steep slopes can be kept more permanently in grass which prevents erosion and the washing away of the surface soil and the loss of fertility.

The agriculture of the county east of the Black River except for small areas where the better grades of soil predominate, is still largly in an undeveloped state. While centers of farming have started around the areas of better soil and around a few small towns, the majority of the land is still covered with brush and is not farmed. This is due in large part to the poor quality of the soils. Groups of farms are found near Shamrock, Millston, City Point, Pray, and Hatfield, and also in the vicinity of Oak Ridge, North Settlement, and Knapp in the interior of this part of the county.

The main crops of the west half of the county where agriculture is highly developed, are the grains and corn and hay

which are largely fed to cattle. The cash crops consist of tobacco, beans, potatoes, rye and on some farms barley, wheat, and oats are sold.

East of the river livestock farming does not thrive so well because of the inferior pasturage produced, except on the patches of better soil mentioned. Clearings are small, only a few head of stock are kept, a little oats, rye and some corn are produced. Partial support of many is derived from picking blue berries, working on the cranberry marshes, or gathering moss or wire grass.

CULTURAL METHODS

In the western part of the county on the heavy soils, some fall plowing is done, but it should be confined to fields where there is not serious danger from erosion. The tendency throughout the county is towards better methods of cultivation, fertilization, and seed selection. It is customary to apply manure to fields to be plowed for corn. When the land is plowed in the fall, manure is often hauled out during the winter and scattered over the plowed field. This is a good practice except where the surface is so steep that fertility is lost by being carried away by rains and melting snows.

In the eastern part of the county where conditions are radically different, other methods are necessary. Spring plowing is better than fall plowing. Covering sandy soils during the fall and early spring with a good growth is a good practice because it prevents loss of plant food by leaching, and the loss of fine sand particles by severe winds. Seeding rye in corn rows at the time of the last cultivation or in potato fields at digging time will prevent some loss of fertility, and this practice should be more generally followed.

Rye seeded early in the fall will help to protect the soil from blowing, but this crop has limitations, and the cheapest and most profitable way of handling the blowing problem is to grow clover and to do this commercial fertilizers may be necessary. With clover to hold the soil in place and a wind break of Jack pine and scrub oak to stop the wind, the blowing problem can be overcome. The use of a corrugated roller is also desirable since this insures a firm seed bed and an uneven surface which offers more resistance to wind. This implement is also needed on peat soil, and every sand and peat farmer should own or have the use of such a roller.

ROTATION OF CROPS*

In discussing rotations, farm crops may be divided into three classes:

1. Grain crops—generally shallow feeders, add little humus or organic matter to the soil, and tend to weediness.

2. Hay crops—legumes, timothy, etc. Legumes have extensive root systems, tap roots, add organic matter or humus and also plant food (nitrogen). They also improve the physical condition of the soil.

3. Cultivated crops—Corn, potatoes, etc., conserve moisture, favor decomposition of organic matter, and destroy weeds. Some are deep feeders, as corn, while root crops are shallow feeders.

A good rotation should necessarily include crops belonging to each of these three classes. The value of such practice is apparent in its effect on the physical condition of the soil, on weediness, on organic matter supply, on plant diseases, and on nitrogen supply of the soil. Better yields are, therefore, obtained when crops are rotated than when a single cropping system is followed.

Again, crop rotation permits raising livestock and means diversified farming. No one will deny the benefits of this type of farming in stabilizing farm business and making best use of labor and equipment the year around.

It should not be understood, however, that crop rotation means maintaining the supply of plant food better than where a single cropping system is practiced. It is often said that certain crops are "hard" on the soil in the sense that they remove more plant food than other crops. In part that is true, but a more important difference is that some plants remove more of certain elements than others. Again a crop like corn, because of its root development and length of growing season, may utilize plant food that is less soluble.

Potatoes require relatively more potassium; corn draws heavily on nitrogen; while legumes are heavy feeders on lime (calcium) and also require large amounts of phosphorus, potassium, and nitrogen (some of which may be extracted from the air in the soil). Again, grain crops and roots require plant

*See Bulletins of Exp. Sta. for more information on Crop Rotation.

VIEW SHOWING PART OF THE BUILDINGS ON THE EXPERIMENTAL FARM, OF THE COLLEGE OF AGRICULTURE, UNIVERSITY OF WISCONSIN AT HANCOCK, WISCONSIN.

Hancock is located in the western part of Waushara County and is also in the sandy belt of Central Wisconsin. The results of experiments on this farm will apply to most of the sandy land in Jackson County.

SIX ACRE ALFALFA FIELD ON PLAINFIELD SAND ON EXPERIMENTAL FARM AT HANCOCK, WISCONSIN

This view shows the crop during the fourth year after seeding. Average yield per acre per year 2½ tons of cured hay.

food that is readily available, while corn is less particular in this respect.

By properly rotating crops, therefore, the soil is subjected to these different "feeding characteristics." One crop compensates for the other, and there is maintained more nearly a balanced condition than with the single crop system.

It is of great importance that in selecting crops to grow, careful consideration be given to the question of climate. This is about the only factor which the farmer absolutely cannot control. A poor soil may be improved, better markets may be found, and better labor secured; but the farmer is powerless to change climatic conditions. He must, therefore, select such crops as are suited to his climate.

The soil is also a factor of great importance. As a general rule, small grain crops do better on heavy than on light soils, and the same is true of grasses grown for hay. On the other hand, the same variety of corn requires a shorter season for maturity on light than on heavy soil. Rather light soils and those of intermediate texture are better adapted to potato growing and root crops. Therefore, on light soils a greater acreage should be devoted to cultivated crops than on heavy types.

Shipping and marketing facilities must also be considered in planning a rotation. The farmer located on a sandy loam farm close to a railroad station or home market will often find it profitable to include potatoes in his rotation. If he is located six or seven miles from a station, the profits from growing potatoes will be much lessened. It will then pay him better to raise more corn for stock feeding, and to convert his crops into dairy products which are less bulky, and which for the same bulk have a greater value.

There is no one best system of rotation. The rotation depends on the system of farming, and this depends largely on the personal choice of the farmer, for some prefer one system and some another. It is highly desirable to rotate crops, but a serious mistake to think that rotation takes the place of other equally sound practices, such as liming and fertilizing.

Following are a few suggestions which will apply to the western part of Jackson county, and may serve as outlines to be modified according to varying conditions.

As much of the land in western Jackson county is quite rolling this factor should be considered in working out a rotation.

One of the chief difficulties on long slopes is that of the tendency of little streamlets to collect into larger streams which greatly increase their eroding power. This difficulty can be overcome to some extent by laying out the fields in long and comparatively narrow strips on the hillsides so that the land which is in tilled crops such as corn or potatoes will alternate with land in grain or hay, thus greatly shortening the distance down the hill through which this accumulation of streams may take place. The sodded strips serve to check the flow of surface water, absorbing it and carrying it off beneath the surface.

A rotation which adapts itself to this system consists of corn, followed by small grain followed by hay for two years. In some parts of the county grain is inclined to lodge. This tendency may be overcome somewhat by growing grain twice in succession on the same fields. Where the slope is not too great this may be safely done, and two crops of corn may also be grown in this way where the slope will permit. A three year rotation may also be used on much of this land. Corn may be followed by a small grain and the grain by clover. Where the fertility is rather low, the second crop should be plowed under as a green manuring crop.

In the sandy portions of Jackson county, somewhat different rotations should be followed. The following is probably the best for most farms of sandy soil:

1st year: Clover with perhaps a light seeding of rye or oats.

2nd year: Clover for hay, leaving the second crop to be turned under either in the fall or spring.

3rd year: Corn or potatoes.

4th year: Soybeans, which may be used for feed, for hay, and for green manure.

If any other crops are to be grown, they may be planted following clover, thus eliminating one of the crops named. Another rotation which is frequently followed on sandy soils consists of small grain followed by clover, followed by potatoes. The second crop of clover in this system should be plowed under as green manure crop.

It is better to use mammoth clover on the sandy soils than red clover, for it is more hardy and more vigorous in growth, being able to secure its plant food more readily. It grows to about the same size on sandy soils as the medium red clover does on heavy soils.

In some of the rotations suggested it may be desirable to substitute rye for wheat or oats, especially on the sandy soils.

Tobacco can be grown on the same field for from two to three years, followed by two years of corn and one of small grain seeded to clover. With the tobacco a phosphate fertilizer should be used to supplement the manure. A second crop of clover can be plowed under, and thus save some of the manure for other parts of the farm. Tobacco should not be grown on the same field for a long period of years as is often the practice.

The growing of peas for canning could be made an important crop in this section, and this crop could be readily introduced into a four year rotation. Such a rotation might consist of small grain, clover, cultivated crops, which would be followed by peas. This may be made a five year rotation by adding timothy and cutting hay for two years. This system would be best suited to the western part of the county where the soils are heavier.

On the marsh lands as they are reclaimed, the question of crop rotation should also be considered. There are three types of farming to which marsh soils are adapted and these are stock raising or dairy farming, trucking and a combination of the two in which neither type predominates. Grain farming can not as yet be recommended on marsh soils. Where a farmer has 30 or 40 acres of peat he can divide the field into four parts and raise cabbage on one, sugar beets on one, grain on one and hay on the other. Thus a four year rotation of hay, sugar beets, cabbage and grain would be practiced on the peat. On a dairy farm two or three crops of corn may be grown in succession but in this region one should take into account the danger from frost. The corn may be followed by grain and this by alsike clover and timothy. The hay may be cut the first year and pastured the second. Potatoes may also be grown on peat land but here again the danger from frost and the quality of the product must be considered. In some localities outside of this area in this and other states a one crop system is being followed where celery, peppermint, or some other crop is the entire source of income. While a rotation of crops on such land is not absolutely essential a change of crops is desirable to aid in the control of weeds and insect pests.

EROSION IN JACKSON COUNTY

The most important single problem in soil management in western Jackson county is due to the large amounts of steep or rolling land. The county is in the so-called residual portion of the state where the streams which drain the area have cut down their beds through the formerly level elevated plain into sandstone rock. These valleys have never been altered or filled by action of glaciers which once covered most of the state. The valleys were at first mere erosion ditches or small stream beds which have been enlarged and deepened during geological ages till their beds lie from 200 to over 400 feet below the ridges which extend between. The valleys and their tributaries radiate like the veins of a leaf and the steep slopes which lead down from the ridge top to valley bottom make up a considerable part of the area of the county.

Most of the soil on the sloping land is heavy and is included in the steep phase of the Knox silt loam. These slopes which originally were timbered or brush-covered have been largely cleared and cultivated. Because of their unprotected condition and exposure to the work of surface run-off water from higher land, fields on this type of soil are often extensively washed and gullied by the storm water and the water from melting snow in spring.

Other soils subject to erosion are the soils of the Boone series derived from sandstone and which often occupy lower slopes in the valleys. The soils of the Lintonia series which lie in narrow benches along the sides of the valley bottoms are also subject to severe gullying. The swift flowing water from the ridges and slopes must cross these benches before reaching the valley stream and deep ravines, gullies, and ditches are developed. Soil erosion is a farm problem not only because fields are cut by ditches and gullies which make cultivation difficult, but because erosion removes the finest and most fertile soil particles first and reduces the fertility and yield of fields by removing fine soil and organic matter from the surface. The causes of removal of soil from the surface without formation of gullies generally lie in improper methods of cultivation or poor arrangement of fields. Fields where this kind of erosion occurs are often only gently rolling or undulating and the rain water does not collect in larger swift-flowing rills or

streams which have power to cut ditches, but follows the cultivated rows such as corn or potatoes or the drill rows of grain fields and the soil is removed only from the knolls and deposited in the hollows.

Contour cultivation and arrangement of the crop rows across the slope instead of with or down the slopes retards the movement of soil in such fields. Keeping the most exposed places in sod as much as possible and the cultivation of the field in alternate strips of crop and sod across the slopes are inconvenient but often necessary methods.

Rotation of crops in such a way that two cultivated crops do not follow in succession gives the field opportunity to recover from its losses under cultivation and avoiding a hard bare condition of the eroded ground after harvest as much as possible prevents surface wash in the fall. A cover or catch crop of rye or peas in the corn rows helps protect the soil after harvest and furnishes pasture until winter.

Deep plowing and plowing under of straw, manure, or a second crop of clover to increase the organic matter in the soil also give the surface of the field greater absorbing capacity and resistance to erosion.

Gullying occurs where greater volumes of water collect forming cutting-streams where steeper slopes cause the water to flow faster or in places where the soil has an unstaple foundation of sandy material which easily undermines when the water once cuts through the surface soil and establishes a fall which cuts back in the sandy subsoil. In some situations large gullies one half mile or more in length are sometimes cut during a single season.

In their beginnings most small gullies are easily handled. Small drainage-ways or shallow ditches can be filed with straw or manure and plowed shut. Such shallow drainageways should be left in permanent sod. The plow can be easily thrown out in passing across them. On the level terraces or where heavy soil lies on light sand or sandy gravelly subsoil, small ditches must be immediately tended to because all ditches on such soil are dangerous.

Where the subsoil is clay and where clay or silt soil material is being brought down by the flood water, large gullies may be made to fill by putting in a dam of stumps, brush, and logs. Where the subsoil is sandy much greater care is required. If

dams are built in the latter case, they need to be carefully constructed to prevent the water from cutting around them.

Dams of concrete, stone, wire mesh, and brush have been successfully used. Flume devices also have been used to carry the water over the head of the ditch and down into it preventing its continued growth.

Planting willows and bushes on the sides and bottom of ditches too deep to fill often arrests the growth of the ditch. Sorghum, sweet clover, or rye make good emergency crops on eroded spots and fields which later need to be seeded to grasses and left in permanent sod.*

DRAINAGE†

In Jackson county there are at least 150,000 acres of land which would be classed as poorly drained, and which must be provided with open ditches or tile drains before cultivated crops can be safely grown from year to year. The major portion of this poorly drained land consists of deep peat, and in the eastern part of the county, the two townships, town 20 and 21 north, Range 1 East, have more than eighty per cent of their area in deep peat. This means that there are over 36,000 acres of this low land in one large body. In addition to this, there are other extensive areas of peat throughout the eastern part of the county. There are also extensive areas of Dunning sand which consist of marsh border soil and this requires drainage, and there is also some land along the Black River which is subject to overflow and which is classed as poorly drained, which is more difficult to reclaim. At the present time there are 46,760 acres of land in drainage enterprises. There are 25.5 miles of open ditches in these drainage enterprises, but only a very small amount of tile has been installed up to the present time. The capital invested in and required to complete operating enterprises in Jackson county amounts to $113,570.

Quite a large number of open ditches have been constructed. Statistics indicate that only 4,140 acres of this drained land are improved at the present time. This means vast areas of land within drainage districts are still lying idle. This is due to the fact that even though outlet ditches have been installed, laterals have not been constructed so that individual tracts of

*See Bulletin 272 of the Wisconsin Experiment Station.

†For a full discussion of drainage questions consult the bulletins of the Wisconsin Experiment Station.

land do not have sufficient drainage at present. Then, too, much of the land is raw, fibrous peat, and this class of soil requires special methods of cultivation and fertilization in order to make its development profitable. It may be stated that most of the marsh land in Jackson county is at present unimproved. The most extensive use which is being made of the marsh land is for wild hay, for moss, and wire grass. Some of the marsh is also utilized for pasture.

The cranberry industry mentioned elsewhere has been developed almost entirely on peat soils, and where this development has taken place, thorough drainage is not wanted in that immediate vicinity. With the proper construction of reservoir and ditches, however, the development of cranberry industry, and the development of farming on cultivated lands need not interfere materially with one another, since the drainage water from one tract may be used at a lower point on the cranberry bogs. It is believed that there is a sufficient fall so that practically all the marsh lands in this county can be successfully drained. Where an area of low land includes part of several farms, the owners can form a drainage district and sell bonds to pay for the improvement. This is the method which has been used, and a number of drainage districts have already been established in the county. In this way the cost of drainage can be spread over a number of years and paid for from the products of the improved acres. Assistance in the development of such projects can, and in fact, must be secured from the state authorities who pass upon the practicability of the project before the court permits the organization of a drainage district. Where the areas of marsh land are small and confined to one farm, and where there is an outlet, the farmer can install tile drains and establish his own drainage system.

For a more detailed discussion of drainage see bulletins 284 and 309, Wisconsin Experiment Station.

LIMING

Most of the soils in Jackson county are thought to be in need of lime. All of the soil types show an acid condition which ranges from slight to strong in degree. The subsoils of many of the types also show some acidity to a depth of from two to three feet. The heavy light colored upland soils are usually

acid at the surface, but the deep subsoil may in places be free from acid or even slightly calcarious (containing lime).

The degree of acidity is quite variable, and each farmer may find a wide variation in the need for lime on his farm. It is essential that every farmer should have his various fields tested before making an expenditure for lime. The county agent can do this, or samples may be sent to the Department of Soils of the University where free tests will be made. Failure of clover and alfalfa are often an indication of the need of lime. About three tons of ground limestone per acre is the usual application on these soils when alfalfa is to be grown and two tons where clover is seeded. The amount to be used, however, may vary with the degree of acidity, the character of the soil, and the crop to be grown. Such crops as alfalfa, sweet clover, peas, cabbages, onions, and lettuce have a high lime requirement. Clover, garden beans, barley, hemp, turnips, and raishes have a medium lime requirement while vetch, white clover, oats, rye, blue grass, potatoes, sorghum, and others have a low requirement for lime. As a rule the heavy types of soil which are acid need more lime than the sandy types showing the same degree of acidity.

Ground limestone is doubtless the most economical form of lime which can be extensively utilized in Jackson county. Lime should be applied previous to planting the crop which is to be benefited. It should be applied to plowed land and thoroughly worked in by harrowing. Either fall, winter, or spring applications may be made.

The best way to apply lime which is dry is with a regular spreader made for this purpose, and there are a number on the market. The end gate type of spreader has given good results in spreading dry or moist lime. A manure spreader may also be used by first putting in a thin layer of manure or straw and spreading the limestone evenly on top of this. Where several farmers are so situated that they can work together, a lime spreader should be secured for this purpose.

After making a first application of two or three tons per acre, it is not likely that another application will be needed for four to six years, and the need should again be determined by soil acidity test, as well as by the story which the crops themselves tell.

It should be remembered that most acid soils are also dificient in available phosphorus, but applying lime will not add to the total amount of phosphorus in the soil. The need of phosphorus may be so great that but little result will be secured from liming until phosphorus is also added. Frequently the application of phosphorus alone to an acid soil will result in larger increases than the uses of lime alone, and for this reason it is important that both deficiencies should be corrected to secure the most economical production.

THE USE OF FERTILIZERS

We believe that most of the nitrogen needed for plant food by Wisconsin crops can best be secured through the growth of legumes and the use of stable manure. Since the legumes require a good supply of available phosphorus, this element should be applied by the broadcast application of phosphate when seeding down to a legume whenever needed. This phosphorus in part becomes available along with the nitrogen of the legume to the succeeding crop of corn, potatoes, sugar beets, tobacco, etc., all of which on upland soils at least should be grown in rotation with legumes, or else on manured land. Only such additional amounts of phosphorus and potash should be applied to these special crops as are needed. These can then be applied in the hill or drill, if desirable.

Peat and muck soils are abundantly supplied with nitrogen which can be made available by proper treatment but are practically always low in potash and freqeuntly in phosphorus, and even sometimes in lime as well.

Only such amounts of nitrogen should be purchased in commercial fertilizers as are needed to supplement the home grown supply. Such supplementary nitrogen should ordinarily be in immediately available form and be used to encourage early growth. Where it is desired to use a fertilizer carrying nitrogen, it is highly important that this fertilizer be applied with a fertilizer attachment on the planter or in such a manner that it will come within the root feeding radius of the plant. Fertilizer attachments are being used for the application of fertilizers for potatoes and corn. For sugar beets the fertilizer should be applied at the time of planting the crop with a regular fertilizer beet drill. Fertilizers for tobacco and cabbage are usually applied broadcast previous to setting, athough it has

been found desirable to apply a small amount of the fertilizer with an attachment on the tobacco or cabbage setter and the balance to be applied broadcast after the crop has developed a more extensive root system. For onions and other truck crops it is usually desirable to apply the fertilizer broadcast previous to planting the crop.

There are three factors which must be considered in relation to fertility and the yield of crops: First, the condition of the soil itself and the supplies of the various kinds of plant food which it offers in available form; second, the crops to be grown, including the kinds and amounts of plant food they require; and third, the use of fertilizers which will supplement the supply of plant food already in the soil in a way to meet the demand of the crops concerned.

Soils vary greatly in the total amount of plant food they contain in available form and especially in the proportion of the various elements required by crops. Sandy and light soils are generally low in most elements. Light colored clay soils are relatively low in nitrogen and are moderately well supplied with phosphates, but contain potash in relative abundance. Peat soils are always abundantly supplied with nitrogen which can be made available by proper treatment, but are practically always low in potash, and frequently in phosphates, and even sometimes in lime as well.

With reference to crops, there are two things to consider: first, the relative proportion of the different elements they require; second, the total quantity needed. While there are undoubtedly slight variations in the requirements of each single individual crop, they can be grouped into classes fairly well. Such crops as small grains and grasses, including timothy, require a relative abundance of phosphates and moderate amounts of potash and nitrogen. Such crops as corn, potatoes, tobacco, and sugar beets require large amounts of nitrogen and potash with moderate supplies of phosphates. Peas, clover, and alfalfa require large amounts of phosphate, potassium, and lime, but under proper conditions can secure most of their nitrogen from the air.

The total quantity of plant food needed depends largely on the total weight of the crop produced. Such crops as small grain, timothy, and flax require but moderate amounts of total

plant food per acre, while such crops as corn, sugar beets, cabbage, onions, and potatoes, require much larger quantities.

The yields of crops are affected not only by the quantity of plant food available, but by the moisture supply which the climate provides and the portion of it which the soils on which the crops are grown will retain until absorbed by the growing plants.

In working out our ideas of the proper fertilizers to use in Wisconsin, therefore, we must take all of these factors into consideration and should use commercial fertilizers only to supplement the natural fertility of our soils and system of farming. Roughly this means that on any particular kind of soil and for the growing of any one of the groups of crops mentioned, the fertilizer best to use would depend on: first, whether stable manure had been used or not; second, whether legumes, which would supply nitrogen but no other element, have been grown; or third, if the soil is unfertilized in either of these ways.

Acid phosphate should be used on the heavier soils in the general system of farming where a sufficient amount of manure is produced to cover the cultivated land every fourth year. This phosphate fertilizer should be used at rates of 125 to 350 lbs. per acre (depending upon the grade) and should be broadcasted or applied with a fertilizer grain drill at the time of seeding to small grain and clover.

Mixed fertilizers high in phosphate (such as 2-12-2) may be used on lighter soils where there is a limited supply of organic matter. For small grain these fertilizers may be applied at rates of 200 to 400 lbs. per acre depending upon conditions. This fertilizer may also be used on corn at rates of 75 to 125 lbs. per acre and should be applied with fertilizer attachments on the corn planter. Fertilizer applied in this manner for corn should be used only as a *supplement to the usual manurial treatment and in conjunction with a practice as previously outlined.*

Mixed fertilizers high in potash may be used for truck crops where it is impossible to secure a sufficient amount of barnyard manure. It is imperative that some legume such as clover or soybeans be grown under this system in order to supply the necessary amounts of organic matter and partly supply the nitrogen. For potatoes the fertilizer should be applied with fertilizer

attachments in the furrows at rates of 400 to 1,000 lbs. per acre. For onions, cabbage, beets, tobacco, etc., the fertilizer may be applied broadcast at rates of 400 to 1,500 lbs. per acre. The conditions peculiar to the individual case will decide the amounts and kind of fertilizer to use.

Phosphate and potash mixtures should be used on the dark colored soils where there is no need for nitrogen in the fertilizer. Soils ranging from the black sand loams to muck and peats fall under this class. The kind of fertilizer and the rate of application will depend upon the type of soil, the crop to be grown and other conditions peculiar to the individual case and no recommendations can be made unless all these factors are taken into consideration.*

FARM PRODUCTS AND AGRICULTURAL STATISTICS

Of the agricultural products of the county as a whole, the cereals lead by far. The farm value of the cereals including corn December 1, 1920, was over two million dollars, while hay and forage were worth less than a half of this amount, and milk produced had a value of over two million dollars.

Among the cereals, oats represent the greatest acreage and production with corn second, barley third, and rye and wheat about an equal fourth.

The towns of Garden Valley, Albion, Franklin, Irving, Curran, Melrose, and Northfield produced the most grains, hay, corn for silage and tobacco, and have the most cows, horses, sheep, and silos. These towns have largely the Knox silt loam soil.

The towns of Cleveland, Hixton, Alma and Springfield with largely fine sandy loam and loam soil lead in acreage of corn for grain, alfalfa, buckwheat, beans and wild hay, and second in number of hogs, silos, and acres of wheat, tobacco, silage, and potatoes.

The towns with largely medium to sandy soil including Garfield, City Point, Manchester, and Komensky, lead in the production of rye, wild hay, and clover. Brockway, Millston, Knapp, and Bear Bluff the most generally sandy towns led in acreage of potatoes, cranberries, and wild hay. Being only

*For a more complete discussion of commercial fertilizers consult the bulletins of the Wisconsin Experiment Station.

partly developed, they do not compare with the production of the more highly developed towns having heavier soil.

Tobacco has the highest acre value of any of the special crops grown in the county. The census of 1920 reports 209 acres devoted to tobacco growing in the county. The acreage on any one farm is small and probably averages no more than two to three acres; so that tobacco is grown on about 100 of the 2,400 farms in the county.

The production of cranberries is a special industry carried on chiefly in the marshy parts of the east half of the county. 1910 census reports 529 acres of cranberries with a yield of 529,000 quarts. In 1920, 480 acres produced 548,648 quarts.

In 1917 about 460 acres of beans were produced in Jackson county. In 1920 the crop was 232 acres yielding 2,344 bushels. These also are generally grown on the sandy soils and in small plots of one-half to two acres extent, although a few fields of from five to twenty acres of beans are grown. The white navy bean is the variety generally grown. The greatest acreages are usually in the towns of Alma, Albion, Hixton, and Garfield.

Potatoes are grown on a commercial scale in parts of the county. The largest acreages are found in Cleveland, Irving, Garden Valley, and Garfield and Alma townships. Potato ware houses are located at Fairchild, Price and Black River Falls, Alma Center, Humbird, and Levis.

Cucumbers are quite extensively grown in portions of the county, chiefly on the sandy and sandy loam soils. Salting stations are located at Merrillan, Black River Falls, Hatfield, Levis, and Taylor. As high as $2.00 per bushel of fifty pounds is paid for first grade cucumbers. Seed is generally furnished and farmers are able to make $100 to $150 an acre from this crop where soil and weather conditions are favorable. This crop is very tender and occasionally early frosts in the fall or the yield.

TABLE OF AGRICULTURAL STATISTICS FOR JACKSON COUNTY FOR 1919 AS COMPARED WITH 1918 AND 1909, FROM BULLETIN NO. 28 OF THE STATE DEPARTMENT OF AGRICULTURE.

Number of Farms	1919	1918	1909
Number of farms	2,479		2,382
Acreage in 22 cultivated crops, including tame hay	133,928	132,564	120,563
Corn, total acreage	23,675	22,204	160,058
Production, bushels	1,089,050	865,956	
Corn for grain, acreage	10,418	8,215	
Production, bushels	489,646	328,600	
Corn for silage, acreage	11,837	12,657	
Production, tons	108,900	101,256	
Silos, number	894	792	
Oats, acreage	41,023	43,764	43,491
Production, bushels	1,394,782	1,925,616	
Winter wheat, acreage	3,314	1,513	3,832
Production, bushels	62,966	27,558	
Spring wheat, acreage	7,322	6,231	722
Production, bushels	87,864	155,775	
Barley, acreage	6,918	9,506	8,868
Production, bushels	179,868	344,322	
Buckwheat, acreage	1,810	2,676	1,994
Production, bushels	28,960	50,844	
Rye, acreage	11,436	9,582	7,457
Production, bushels	194,446	182,058	
Peas dry, acreage	272	111	32
Production, bushels	2,992	1,332	
Dry beans, acreage	137	390	207
Production, bushels	2,055	4,680	
Clover and timothy, acreage	33,545	32,032	34,227
Production, tons	53,672	48,048	
Alfalfa, acreage	104	98	20
Production, tons	322	245	
Other tame hay, acreage	661	496	404
Production, tons	859	794	
Wild hay, acreage	3,370	3,812	3,774
Production, tons	5,055	4,574	
Potatoes, acreage	2,471	2,651	2,189
Production, bushels	232,274	288,939	
Tobacco, acreage	550	625	338
Production, pounds	715,000	843,750	
Cabbage, acreage	12	33	10
Production, tons	91	99	
Sugar beets, acreage	16	103	166
Peas for canning	121		
Other root crops	36	16	
Flax, acreage	50	30	
Acreage in 22 cultivated crops, including tame hay	133,928	132,564	120,563
	1920	1919	1910
Milk cows, number January 1	19,762	19,391	17,077
Other cattle	23,978	22,879	14,750
Number of horses and mules, January 1	9,044	9,291	8,514
Number of swine, January 1	29,662	30,615	18,615
Number of sheep, January 1	12,198	14,630	7,966
Milk produced, cwt.	876,865		

Average production, per cow, 4,488 pounds of milk.

AGRICULTURAL HISTORY

Agriculture in its early stages followed close on the heels of the lumberman. Pine forests lined the Black River and covered the east half of the county. During the process of marketing this timber, railroads were built, sawmills established, and towns grew up around the sawmills and lumber camps. Roads were opened from town to town, and the land seeker was attracted to the locality.

The first settlement began about 1850. Wheat was the popular crop at first because it always found a market. Many farmers hauled their wheat twenty to forty miles or more with ox teams to the nearest railroad point. The grain raising was confined to the western half of the county where most of the soil is heavy and better adapted to grains than the soil of the east half of the county.

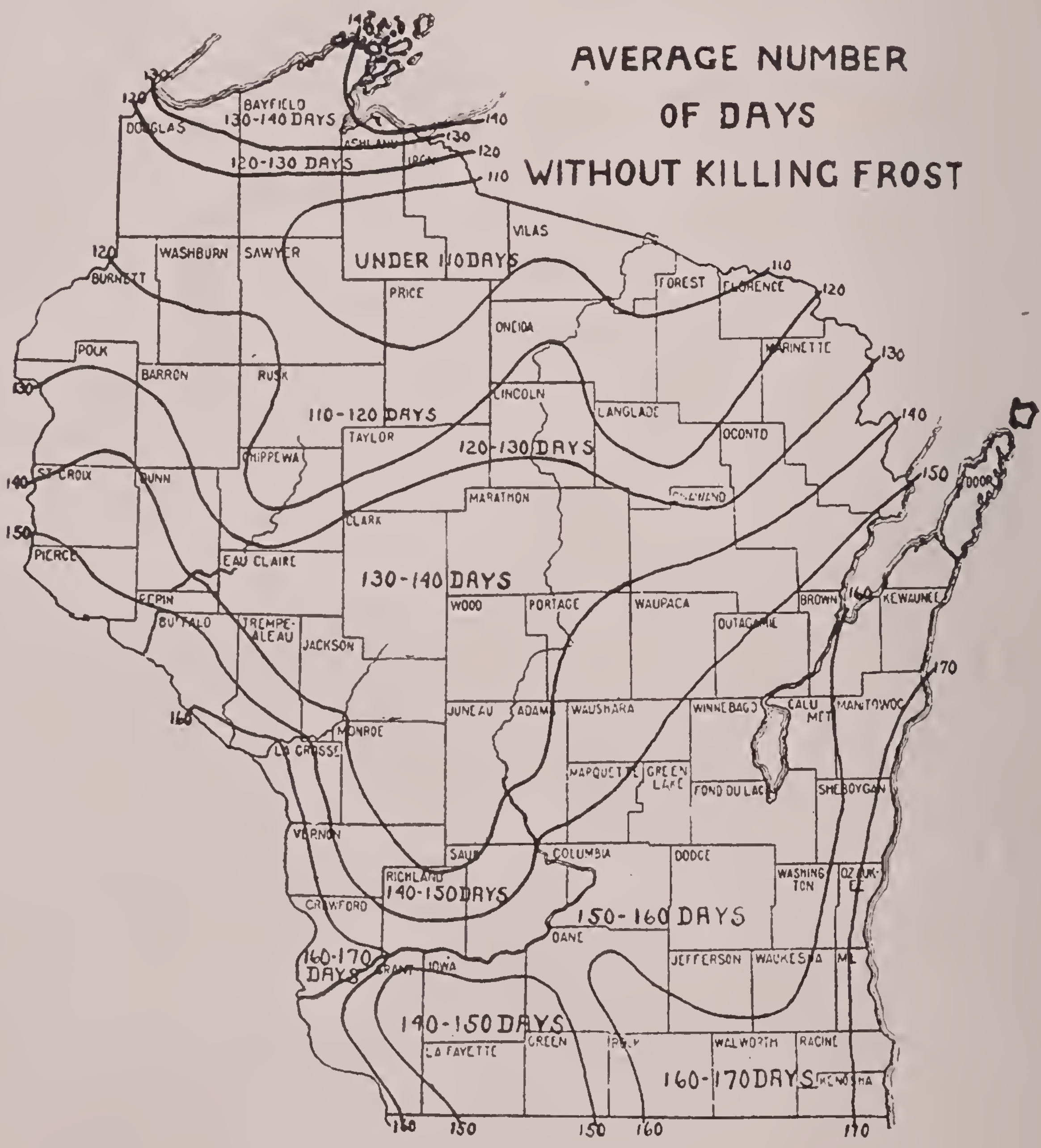
By 1880 there were 1600 farms which have increased to about 2500 at the present time. Since 1880 wheat raising has declined two-thirds while oat growing has increased four, and rye seven times. Due to the too continuous raising of wheat, the yields were reduced for a time and because also of low prices and plant diseases the raising of this crop fell off. As communication and marketing facilities became better, live stock and dairy farming came to the front. At present much more live stock is sold from the farms than formerly and cheese factories and silos are becoming generally distributed in the west half of the county, though grain raising still holds a large share of the agricultural activity of several of the townships.

Agricultural development in the eastern half of the county has been very slow, and by far the greater proportion of this land is unimproved. Future progress in this region will depend upon the drainage of the marshes and in the development of methods through which the farming of the sandy soils and marsh lands can be made profitable.

CHAPTER VIII

CLIMATE

The climate of that portion of Jackson county lying east of Black River is typical of the large area of central Wisconsin which has been described in a study of the climate of Wisconsin* as the Wisconsin River Basin. This region appears to be slightly



cooler than the Mississippi Valley to the west or the Michigan shore to the east, being cooler than the former in summer, and colder than the latter in winter. This Wisconsin River Basin averages about ten days in winter when the temperature drops

*Wis. Exp. Station Bulletin No. 223.

lower than ten degrees below zero, and thirteen days in summer when the termometer rises above ninety. The growing season is somewhat shorter, owing probably to the altitude and the sandy soil and marshy condition of much of the land. Mauston, which is the county seat of Juneau county, has an average season of 130 days between frosts as compared with 160 days at La Crosse to the west, 149 at Oshkosh, and 167 at Sheboygan at the east. Stevens Point has an average growing season of 126 days. From the accompanying chart it will be noted that the growing season of the Wisconsin River Basin averages from 130 to 140 days between killing frosts. There are many places with this basin, however, especially along the marsh land where killing frosts may occur any month during the year.

The western part of Jackson county which ranges in elevation from one to three hundred feet above the eastern portion, falls within the southern Highlands Division as another climatic province in Wisconsin. This region is extremely rough and broken, and by consulting the chart it will be noted that a portion of this region has a growing season somewhat longer than the region in the Wisconsin River Basin. This region is almost entirely free from marshes; practically all of the land is well drained.

From the appended table of average temperatures and rainfall from the station of Hatfield in Jackson county, it will be noted that the annual temperature is 44.1 degrees Fahrenheit, and the annual mean temperature is 30.62 inches. This rainfall is so distributed that the greater part of it comes during the growing season, and while this is true, it frequently happens that during the latter part of the summer of some years, crops suffer from a lack of moisture. This is especially true on the soils of light texture, which predominate in the eastern part of the county. The average date for the last killing frost in the spring at Hatfield is May 20, and the day of the first killing frost in the fall is September 21, giving an average growing season of 124 days. This is somewhat shorter than the period given for the whole Wisconsin River Basin.

This short growing season as well as the sand soils aid in explaining the comparatively small amount of corn raised in this region, and the more extensive development of the potato industry. While corn does not always mature in this region, it can be safely grown as a crop for the silo, and for such use, the acreage could be materially extended.

The following table gives the average annual temperature and rainfall conditions at Hatfield, a station in the north central part of the county on the Green Bay Railroad.

Mean temperature in degrees Fahrenheit:

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
14.9	14.3	28.4	46.9	58.8	66.9	70.6	67.7	60.8	48.8	32.4	18.5	44.1

Mean rainfall in inches:

0.83	0.71	1.29	2.48	4.63	4.50	3.56	3.09	3.49	3.07	1.61	1.36	30.62

SUMMARY

Jackson county is located in the west central part of Wisconsin, and comprises 1,001 square miles or 640,640 acres. It may be divided roughly into two distinct topographical and agricultural regions. The western part, west of the Black River, is largely a rough rolling country with soil of good quality predominating and an agriculture which is highly developed, while east of the Black River the region is largely an extensive sandy plain with many marshes, with the predominating soil of low agricultural value and being but slightly improved.

While the first settlement was made as early as 1818 or 1819, there was but little in the way of agricultural development prior to 1850. The county was established in 1853, and the village of Black River Falls was incorporated in 1866. All of the western part of the county is now well settled, but in the eastern part the region is very sparsely settled.

Two railway systems traverse the area, and these provide transportation facilities for the region, although some portions of the county are quite distant from the nearest shipping point. From Black River Falls to Madison is 127 miles, and to Chicago 250 miles, while to Minneapolis it is 152 miles. These distances are over the Chicago and Northwestern Line.

The mean annual temperature is about 43.8 degrees, and the mean annual precipitation 31.6 inches. The marshy region in the eastern part of the county is much more liable to have summer frosts than the hilly country to the west.

In the western part of the county, agriculture is well developed, and the region is in a prosperous condition, while in the eastern part there is but little development, due to the sandy and marshy condition of the soils.

Jackson county lies almost entirely within the unglaciated portion of the state, and the soils have been derived largely from the disintegration products of the underlying sandstone and shale, and also from the wind blown material known as loess. In addition to these sources of origin there are also large tracts

which have been modified by the action of water and deposited in the form of stream terraces or valley fill. Accumulations of vegetable matter have also given rise to extensive bodies of peat, and smaller accumulations of organic matter have modified several of the various soil formations.

Including rough stony land and peat, twenty-eight types of soil were recognized and mapped in Jackson county.

The Knox series includes the light-colored upland soils which are largely of loessial origin, and which include the best extensive tracts of land in this region. Knox silt loam, with its steep phase was mapped.

The Boone series includes soils derived directly from the weathering of the Potsdam sandstone. In some cases some shale and also loess had modified some of the types. The types mapped are Boone loam, fine sandy loam, fine sand, sand, with phases of some of these types.

Lintonia soils are made up chiefly of secondary loess now found as terraces throughout the region of Knox soils. The types mapped are Lintonia silt loam, loam, and fine sandy loam.

Bates soils are very similar to the Knox, except they are dark-colored, semi-prairie soils. The silt loam was the only type mapped.

The Plainfield series consists of light-colored alluvial soils found as terraces, valley fill, or outwash plains. In this county, the following types were mapped: Plainfield fine sandy loam, sandy loam, sand, and fine sand.

The Vesper series consists of residual soils which have been derived largely from a shaly phase of the Potsdam sandstone, and which usually have a subsoil containing considerable clay or shaly material. They are nearly level, and usually rather poorly drained because of the shale in the subsoil. The types mapped are Vesper silt loam, fine sandy loam, and sandy loam.

The Dunning series consists of low lying dark-colored poorly drained sandy soils bordering marshy tracts. It may be residual or alluvial in origin. Only the Dunning sand was mapped in this area.

The Wabash series includes the dark colored bottom land soils in the western part of the area, where the upland soils are largely Knox silt loam. The types silt loam and loam were mapped.

The Genesee series includes the light-colored first bottom soils. The types mapped are silt loam, fine sandy loam, and fine sand,

Peat consists of decaying vegetable matter in various stages of decomposition. Several depths were indicated in the field work, and of these, the shallow phase is shown on the final map.

Rough stony land consists of steep, rough, and rocky land which is too rough or too rocky to be cultivated. Its chief value is for the limited amount of pasture which it affords.

/ISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

W: O: HOTCHKISS, Director and State Geologist

A: R: WHITSON, In Charge Division of Soils

OIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE

H. L. RUSSELL, Dean

BULLETIN NO. 54--C **SOIL SERIES NO. 25**

SOIL SURVEY

OF

WAUPACA COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, AND MARTIN O. TOSTERUD

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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*Scientist in Soil Survey, In charge of field parties for The Bureau of Soils, U. S. Department of Agriculture.

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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering

suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis,* which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater

proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20-50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay.—Less than 20% silt.

Soils Containing over 50% of Silt and Clay.

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.—Over 30% clay.

Soils may may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for examples, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

By uniting the soil class with the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF WAUPACA COUNTY, WISCONSIN

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA

Waupaca County is situated a little to the east of the center of the State of Wisconsin. It comprises an area of about 759, square miles, or 485,760 acres. Waupaca, the county seat, is 221 miles from Chicago and 146 miles from Milwaukee by rail.

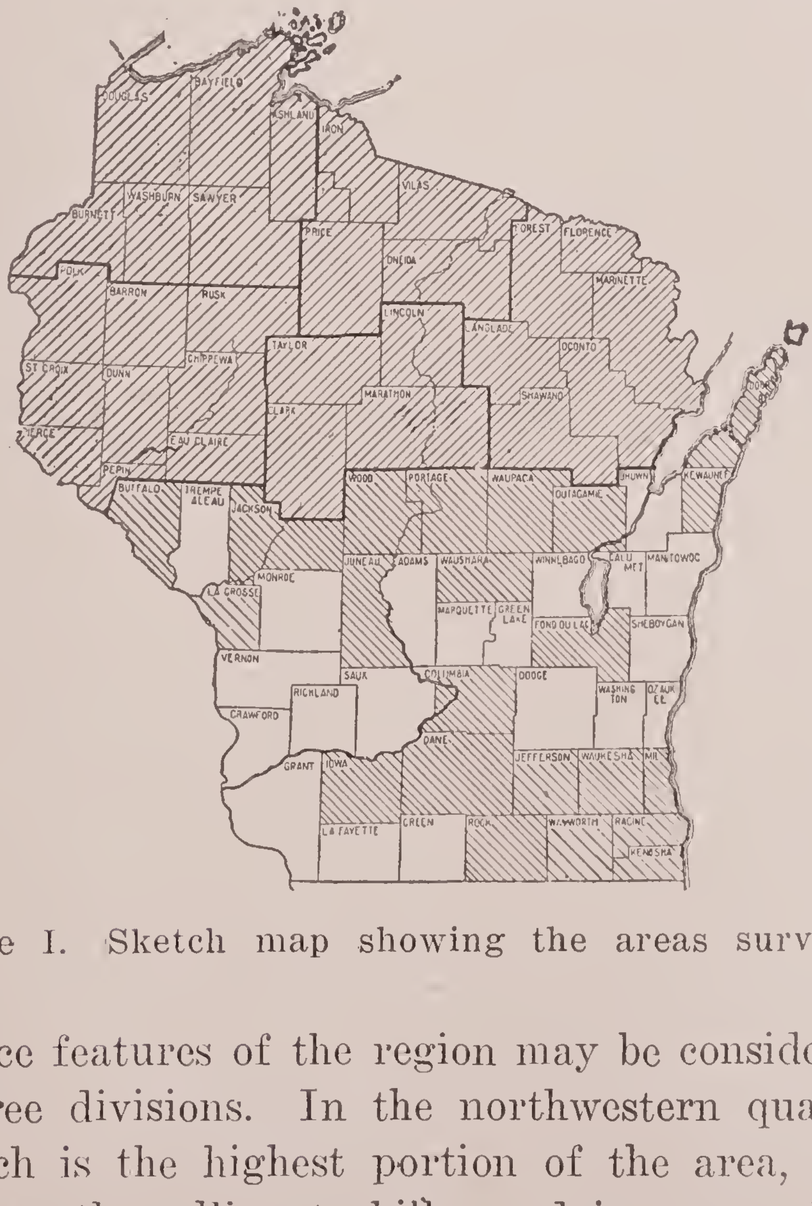

Figure I. Sketch map showing the areas surveyed.

The surface features of the region may be considered as falling into three divisions. In the northwestern quarter of the county, which is the highest portion of the area, the surface varies from gently rolling to hilly, and in many places stones and boulders are very plentiful. This portion of the county is underlain by granitic rocks which outcrop frequently.

The southwestern quarter of the county is characterized by extensive sandy plains. The surface is, for the most part, level and is almost entirely stone free. In this region there are a number of beautiful lakes chiefly in Farmington and Dayton townships.

The region which may be considered as forming the third class occupies the greater portion of the east half of the county. The surface varies from level to gently rolling, and the most characteristic feature is the heavy red clay subsoil. This is the lowest portion of the county. While the underlying material is of a clayey nature, and while the surface soil is also frequently heavy in character, there are a number of places throughout this region where there are areas of fine sand which appear to have been dumped down upon the red clay. It is frequent to find therefore very sharp soil boundary lines where the range in texture changes from a fine sand to a loam or clay within a very short distance.

The region of highest elevation is found in the northwestern part of the county, and the general slope is from this section to the south and also to the east. Elevations above sea level at various places are as follows: Iola 930 feet; Waupaca 870 feet; Manawa 828 feet; Northport 779 feet; New London 767 feet; and Weyauwega 779 feet.

All of the county lies within the drainage basin of the Wolf River, which flows in a southwesterly direction across the southeastern portion of the county. The Embarrass River, which is one of its largest tributaries, enters the Wolf near New London a short distance outside of Waupaca County. The Little Wolf, Pigeon and Waupaca Rivers are smaller streams within the county. All of these drainage waters flow through the Wolf into the Fox River and thence into Green Bay and Lake Michigan.

Scattered throughout the county are numerous marsh areas and some lakes. The most extensive tracts of marsh are found in the southeastern quarter of the county along the Wolf River. For the most part the marsh areas of this county are still undeveloped.

The Wolf River as it passes through this county is very sluggish. The entire fall between Shawano and where the Wolf joins the Fox River is less than one-half foot per mile. The Embarrass River where it crosses the county is also sluggish. The streams flowing into these two rivers, however, from the

west and coming out of the higher portions of the county, have considerable fall. Water power is being used in a limited way on these streams at Big Falls, Waupaca, Manawa, and Weyauwega. There is considerable water power on these small streams which is still undeveloped. The water supply for stock and farming purposes throughout the county is excellent. In the eastern half of the county there are many flowing wells and in the western half excellent water can be secured without difficulty.

The first settler is reported to have arrived in Waupaca County in 1843, settling at the present site of Fremont. By 1849 a number of settlers had taken up lands in the southern part of the county. The county was organized practically as now existing, in 1851—claims to the territory being finally surrendered by the Menomonie Indians in 1852.

In 1910 the population *of Waupaca County was 32,782. Of the total population 83.7% is classed in the census report as rural. The density of the rural population is given as 36.1% persons per square mile.

Waupaca, the county seat, had a population in 1910 of 2,789. New London, with a population of nearly 4,000, is located on the east county line, partly in Waupaca and partly in Outagamie County. Among other towns and villages within the area are Clintonville, Marion, Manawa, Ogdensbúrg, Scandinavia, Iola, Weyauwega, Fremont, Royalton and Northport.

Three railway systems have lines extending into this county. These railroads offer good transportation facilities to nearly all portions of the county. In the southwestern portion and in other regions where the soils are sandy, the wagon roads are usually of a sandy nature. Throughout the remainder of the county where the soils are heavier, the roads are naturally better. In many places they have been macadamized, and new and improved highways are constantly being built. Rural mail delivery routes reach all parts of the county, and the telephone is in common use through the country districts.

The towns within the county provide markets for considerable farm produce, but most of the surplus from the farms is shipped to outside markets. Live stock goes mostly to Chicago

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* In the edition of this report published by the U. S. Bureau of Soils the population of Waupaca County was erroneously given as 23,782 for 1910.

and Milwaukee, as does also the potato crop. Dairy products find a market throughout the middle west.

SOILS

Waupaca County, in common with several other counties in the central portion of Wisconsin, owes the general character of its surface material to several distinct methods of accumulation. These materials may be glacial, lacustrine or alluvial. To these important agencies may be added the accumulation of organic matter in low places which has resulted in the formation of peat.

In the geological classification based upon the character of the underlying rocks, the county falls into three divisions. The surface rock in the northwestern portion of the county consists of crystalline rock, chiefly of granite and gneiss. Throughout this granitic rock region, rock outcrops are frequently seen. Stone and boulders are plentiful.

In the extreme southeastern corner of the county in the southeastern portion of Caledonia township, there is a remnant of Lower Magnesian limestone which outcrops or comes very near the surface in Sections 11, 12, 13 and 14.

All of the remainder of the county, which makes up a total of over half of the area surveyed, has Potsdam sandstone as the surface rock formation. As this rock is rather soft there are but few outcrops, and in most cases it is buried at a considerable depth by glacial, lacustrine and alluvial materials. The accompanying sketch shows the extent of the three rock formations within Waupaca County.

All of the county has been traversed by an ice sheet of the Late Wisconsin glaciation. The section of the county having the most pronounced glacial features is the west half of the county, and especially the northwest quarter. Stream terraces and outwash plains are numerous in the southwestern part of the county, and rather extensive terraces are also found along Pigeon River in the north-central part of the county. Extensive alluvial deposits occur along the Embarrass and Wolf Rivers. Pot-holes, recessional moraines and drumlins are other evidences of glaciation which are found in various parts of the county. Marshes are quite plentiful, and from a geological standpoint the topography of the whole area is young. The

large number of boulders which occur have probably not been transported for any great distance.

The rock formations in the county have contributed to a greater or less extent in the formation of the soils. By far the greater proportion of the material has come from crystalline rocks and from sandstone. Since these materials were first deposited by the ice sheet they have been modified by running water, by the action of wind, by weathering and by accumulation

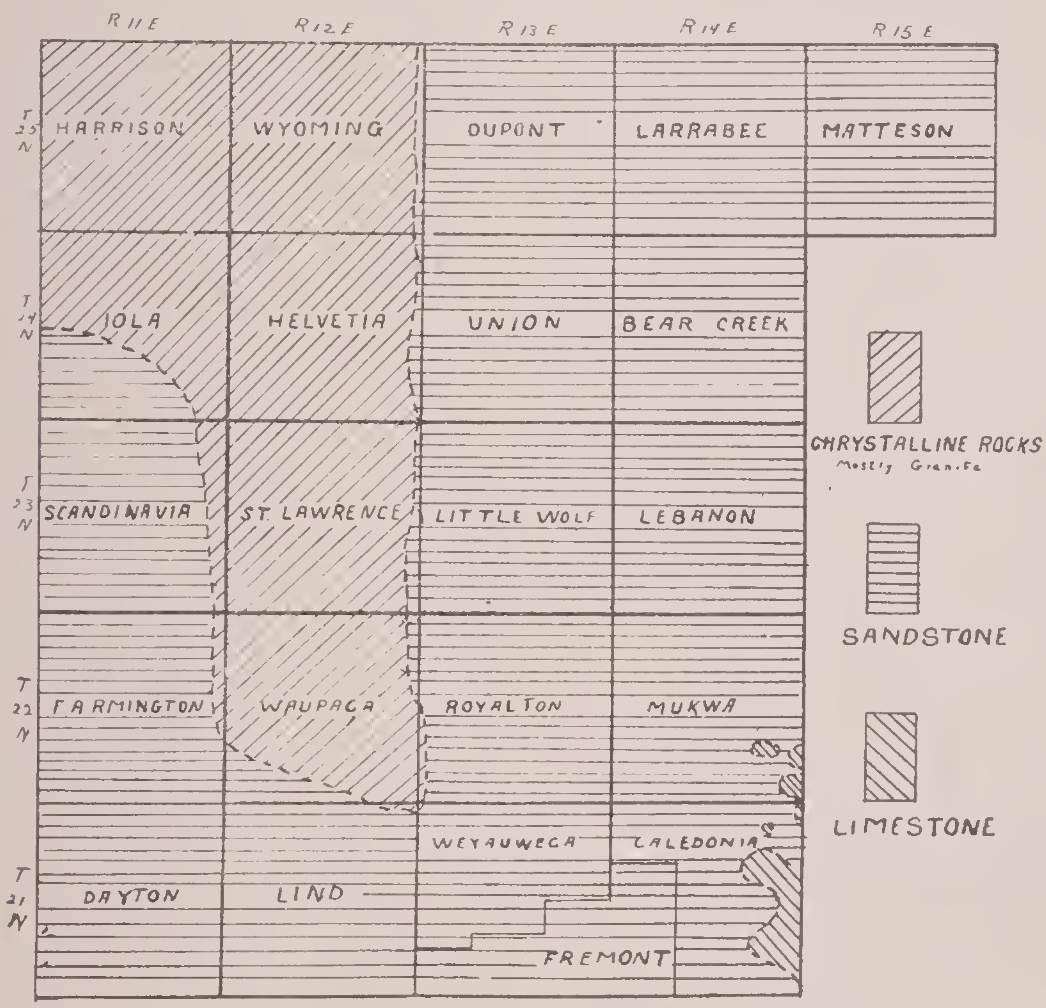

Fig. 2. Sketch map showing the surface rock formations in Waupaca County. All of these formations have contributed to the making of the soils.

and decay of vegetable matter. In the soil survey of Waupaca County the soils have been classified into eight series and thirty-two types, not including peat. In several instances, phases of some of the types have been recognized.

The soil series (which correspond to the family groups) are not shown on the soil map which accompanies this report, and are described here only very briefly. The individual soil types, however, are shown on the map, each being indicated by a distinct color. It is the soil type in which we are especially interested, since the type is the unit in mapping and classification of soils. Following is a complete list of the soil types mapped in the county and the series or family groups to which each type

belongs. Following this general discussion of the soils will be found a full and detailed description of all of the types, together with statements covering the present uses of the soils and the methods through which each type can best be improved.

The Kennan series includes light colored upland soils in the timbered regions where the soils have been derived through glacial action from granitic rocks. These soils are always acid, and are frequently quite stony. The types mapped in Waupaca County are the Kennan fine sandy loam, loam and silt loam.

The Antigo series also includes light colored upland soils in the timbered region where the material has been derived from glaciated granitic debris which has been deposited by water in the form of level plains taking the form of outwash plains or stream terraces. The lower subsoil of the types in this series is usually sandy or gravelly. The types mapped are the fine sandy loam, loam and silt loam.

The most characteristic feature of the Superior series is the heavy red clay subsoil which was deposited in quiet waters and later modified to varying degrees by glacial action. Typically the surface is level or nearly so, and the natural drainage somewhat deficient. Where the surface is sufficiently rolling to insure fair to good drainage the term "rolling phase" is attached to the various types. The types mapped here are the Superior sandy loam, fine sandy loam, loam, silt loam and clay loam. All of these types except the clay loam have a rolling phase which is shown on the map.

The Coloma series includes light colored upland soils where the material has been derived chiefly from sandstone rocks through glacial action. Varying amounts of granitic material are mixed in with the sandstone particles. The types mapped are Coloma sand and fine sand.

The Plainfield series is made up of the same material as the Coloma except that it has been deposited by water in the form of level plains, known as stream terraces or outwash plains. The types mapped are the Plainfield fine sand, sand and sandy loam.

The Whitman series includes dark brown to black soils which occur in depressions or along stream channels where the material has been derived largely from granitic glacial drift. On account of the low position and poor drainage there has been an accumulation of organic matter which accounts for the dark color. The only type mapped in this area is Whitman silt loam.

The Poygan series includes the dark brown to black soils which occupy depressions in the region of Superior soils. The subsoil is the same heavy red clay found under the Superior types. The natural drainage is poor and there has developed a considerable amount of organic matter in the surface soil. The types mapped are Poygan fine sandy loam, silt loam and clay loam.

The Dunning series includes dark colored, light textured soils occupying low poorly drained areas, chiefly in the region where the soils are largely of sandstone origin. The only type mapped in the series in Waupaca County is Dunning fine sandy loam.

The Genesee series includes the brownish soils which occur as first bottom land along the streams of the area. This land is subject to annual overflow and so can seldom be utilized for cultivated crops. The types mapped are the fine sandy loam and silt loam.

In addition to the soils included in the nine series described above, a large amount of peat has been mapped. This peat consists of accumulations of vegetable matter in varying stages of decomposition and with which there has been incorporated a small proportion of mineral matter.

In subsequent pages of this report the various soil types mapped in Waupaca County are discussed in detail. The distribution of the various soils is shown on the map accompanying this report.

CHAPTER II.

GROUP OF HEAVY SOILS

Kennan Silt Loam

Extent and Distribution.—This type is not extensive, it covering a total area of *less* than 16 square miles. It is confined almost entirely to the northwest quarter of the county. Tracts seldom exceed two square miles in extent. Most of this soil is found north of Waupaca, between Waupaca and Scandinavia, to the west of Scandinavia, and also to the west and south of Iola.

Description.—The surface soil of this type to a depth of about 10 inches consists of a brown or grayish-brown, or in the upper few inches of virgin areas dark brown, friable silt loam. The subsoil consists of yellow or light yellowish brown silt loam, which usually becomes somewhat heavier with depth to 16 to 24 inches, where the texture is lighter,—a fine sandy loam, sandy loam, or sandy clay loam, usually containing varying amounts of fine gravel. The line between the silty covering and the coarser material is often quite sharp. The surface material is usually free from gravel, while the deep subsoil may contain a considerable amount of it. Boulders occur on the surface in rather irregular distribution. In places they are sufficiently numerous to interfere with cultivation. Some have been removed, but others are so large that moving them is difficult. Some areas are practically stone free.

Topography and drainage.—The surface varies from gently rolling to hilly, and because of the surface features the natural drainage is good. There is not much danger from erosion, although this should be kept in mind, and the steeper slopes kept covered with a growing crop as much of the time as possible.

Origin.—The material forming this soil has been derived largely from crystalline rocks through glacial action. Nearly all of the boulders present are of crystalline rocks also. There is no calcareous material present and both soil and subsoil are acid.

SHOWING GENTLY ROLLING SURFACE FEATURES CHARACTERISTIC OF A LARGE PROPORTION OF THE SOIL IN THE KENNAN SERIES.

Many areas of this soil are stone free, or nearly so. The silt loam, loam and fine sandy loam as found in this county are for the most part, very good agricultural land.

SHOWING UTILIZATION OF STONY LAND.

Soils of the Kennan series are stony in some places and stone free in other places. Where the stones interfere seriously with cultivation, the land, such as shown here, supplies excellent grazing.

Native vegetation.—The original timber growth on this soil consisted of maple, birch, hemlock, with some basswood, oak and elm. Some white and Norway pine were also mixed in with the hardwood. All of the pine has been removed, and the best of the hardwood has also been cut, but there are still limited tracts where some merchantable timber remains.

*Present agricultural development.**—A considerable proportion of this type is cleared, under cultivation, and in highly improved farms. It is good soil for general farming and dairying—the chief lines to which it is devoted. The chief crops grown are small grain, corn, and hay. Potatoes are also grown on a commercial scale on some farms, and sugar beets do well, though not grown to any extent at present. Peas are grown to a limited extent. Corn for ensilage is a certain crop, but corn will not always mature in this latitude on account of frosts. By growing early varieties and by selecting the fields which warm up readily and permit early planting, the danger from frosts can be materially reduced. Commercial fertilizers will hasten growth and frequently reduce the time required for maturing the crop by one or two weeks.

Antigo Silt Loam

Extent and distribution.—This type is of limited extent and is found chiefly in the west central part of the county in the vicinity of Sheridan, about 2 miles north of Waupaca, south of Scandinavia and between Scandinavia and Iola.

Description.—The surface soil of the silt loam to an average depth of 8–10 inches consists of a grayish brown silt loam which frequently approaches a loam in texture. The material is usually rather compact in its natural condition but when placed under cultivation, its structure permits the securing of good tilth very readily. The upper subsoil consists of a light brown, compact loam or silt loam which at about 14–16 inches grades into a buff colored or slightly yellowish brown silty clay loam. Below 24 inches, the subsoil changes abruptly into a mixture of sand and gravel containing very little clay. The depth to this gravelly material is variable and in several instances was found to vary from less than one foot to about three feet.

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* For chemical composition and fertility see page 20.

In most cases this soil is free from large stones and bowlders; although about the margins of areas some may be found, and stones from 4–8 inches in diameter may also occur in small numbers.

Topography and drainage.—The surface varies from level to very slightly undulating and because of the underlying coarse material, the natural drainage is good. There are only a few small sags or potholes where the drainage is deficient.

Origin.—The type is of alluvial origin and consists largely of crystalline glacial debris deposited as outwash material or valley fill. None of the soil-forming particles are of a calcareous nature, and the type shows varying degrees of acidity.

Native vegetation.—The original timber growth consisted of maple, birch, and hemlock with a small amount of pine.

Present agricultural development.—Antigo silt loan is an excellent soil and most of it is cleared, placed under cultivation, and in prosperous farms. Its freedom from stones makes it more desirable than some of the upland types. The type is well adapted to small grains, grasses, potatoes, root crops, etc. Corn makes excellent silage and often matures, but cannot be counted on to mature every season.

CHEMICAL COMPOSITION AND FERTILITY OF ANTIGO SILT LOAM, AND KENNAN SILT LOAM

The soils of the Antigo, and Kennan series have a good supply of the mineral elements phosphorus and potassium.

Phosphorus.—The total amount of phosphorus in an acre to a depth of 8 inches varies from 1,100 to 1,400 pounds. This would be sufficient for 100 to 150 crops if all were available, but it is never practicable to secure good growth from such soils after the total phosphorous has been reduced to six or eight hundred pounds and better results are always secured when the total phosphorous content of this layer of soil is retained at from 1,500 to 2,000 pounds per acre 8 inches. A farmer on this land, therefore, should adopt plans which will maintain the present supply of this element rather than attempt to draw on it even for a short number of years. The availability of this element requires a good supply of organic matter.

Potassium.—The element potassium exists in very much larger amounts in these soils than does the element phosphorus—in fact they contain on the average approximately 30,000 pounds

of this element per acre to a depth of 8 inches. This is a sufficient supply to meet the demands of heavy crops for several hundred years. The entire problem with reference to potassium therefore, is connected with its availability. When a good supply of active organic matter is present it can be assumed that there is sufficient potassium made available for practically all crops grown on this land. In the case of a few special crops requiring unusually large amounts of this element, such as cabbage and tobacco, the use of potash fertilizers may in some cases be profitable. The system of farming followed will also influence the potassium supply. A large part of this element goes to the stalks and straw of the plant so that if the hay and rough forage is fed the greater portion of this element is returned to the land in the manure—differing radically from phosphorous which goes to the grain and is, therefore, more likely to be sold.

Organic matter and nitrogen.—Compared with prairie soils which have shown a lasting fertility, these soils are distinctly low in organic matter and nitrogen. In fact, most upland soils of wooded regions are low in organic matter. However, the vegetable matter which they do contain when first cleared and broken is of an active character, but provision should be made for maintaining and increasing this material. When stock raising is practiced manure is available and is of course good as far as it goes, but on comparatively few farms is there sufficient manure produced to maintain the organic matter in soils of this character and other means should be used to supplement the barnyard manure. Green manuring crops should be used as far as possible, turning under the second crop of clover whenever this can be done rather than using it for pasture. Seeding clover in corn at the last cultivation will secure good growth when the season is favorable. Cultivated ground when used for pasture should not be grazed closely.

Nitrogen is perhaps the most essential element of plant food and large amounts are used by all crops. It exists only in the organic or vegetable matter of the soil, there being none whatever in the earthy material derived from the rocks. Soils which are low in organic matter are therefore, also low in nitrogen. By all means the cheapest source of this element is through the growth of legumes such as clover, alfalfa, soy beans, etc., which collect it from the atmosphere. When these crops are turned under they contain an abundance of this element.

When fed to stock a portion only is returned to the land. But when land of the character of that under discussion is used for mixed farming so that at least one-fourth produces a good crop of clover or alfalfa each year the supply of nitrogen can be maintained on a dairy or stock farm, but where any considerable portion of the land is in crops which are sold entirely one-third or more would have to be in some legume crop to maintain the nitrogen supply.

Acidity and liming.—Since all of these soils were formed from rocks not containing lime carbonate they are essentially all acid. The degree of acidity varies from one which would require 1,000 to that which would require 5,000 pounds or more lime to correct. This acidity is not in itself a direct detriment to the growth of most farm crops but is an indication that there is not enough lime present for crops which need a good deal of that element. Clover will do well while this soil is new even though acid, but after this land has been cropped a number of years the acidity should be corrected to secure the best results with medium red or mammoth clover. Alfalfa is very sensitive to acidity and lime in some form must be used to secure good results with this crop even on new land. Other crops also are benefited by lime.

Crops.—The Antigo and Kennan soils are adapted to a wide range of crops including corn, potatoes, and root crops as well as grasses and small grains. The soils of these types are well adapted to the development of dairy farming on account of their unusual fitness for the growing of hay and pasture.

SUPERIOR CLAY LOAM

Extent and distribution.—The Superior clay loam is confined to the eastern half of the county chiefly to the south eastern quarter within the valley of the Wolf River. The most important areas are found in the vicinity of Fremont and Weyauwega. A few small tracts are found near Clintonville and Northport also, and others are scattered about through the eastern part of the area.

Description.—The surface soil of this type to an average depth of 6 to 8 inches consists of a grayish-brown to light chocolate brown clay loam or frequentlya silty clay loam. The subsoil is a heavy, compact pinkish-red clay which extends to a depth greater than three feet, though below 30 inches the ma-

terial frequently becomes somewhat lighter, both in color and texture. Throughout the subsoil thin streaks of ashy gray frequently appear, and it is probable that these mark the location of former cracks into which surface silty material has been washed. Upon drying large cracks are formed in the surface and these extend to a considerable depth into the subsoil. These are of course most noticeable in uncultivated fields. Occasionally water worn gravel and a few small stones are found upon the surface and mixed with the soil but these are always of very limited number. In some places in the deep subsoil there is found a substratum of medium to fine sand. This is seldom more than a few inches thick when the red clay is again encountered. This condition is found chiefly east of Fremont.

Topography and drainage.—The surface of the Superior clay loam is level or nearly so, and because of the heavy character of the subsoil the natural drainage is deficient. Many farmers have laid out open ditches or have laid out the fields in narrow lands so that the dead furrows would serve as surface drains. Some of the most progressive farmers have installed tile drains with very marked success and it is only a question of time until practically all of this type will be fully tile drained.

Origin.—The material forming this soil is largely of lacustrine origin, but since its first deposition by quiet waters it has been more or less influenced by the action of glacial ice. Typically the Superior soils contain considerable carbonate of lime, and varying amounts are found in this type, especially in the subsoil. The surface is usually not acid, though in some cases a slight acidity has developed.

Native Vegetation.—The original timber growth consisted of hickory, oak, elm, birch, some maple, and poplar. By far the greater part of the timber has been removed.

*Present agricultural development.**—A considerable proportion of the Superior clay loam is being utilized for farming purposes. The best drained portions are devoted to cultivated crops, and the less well drained tracts are used for hay and pasture. When thoroughly drained this is an excellent soil, though some what difficult to handle because of its heavy texture. It is devoted to general farm crops consisting of hay, small grains, corn and potatoes, and where drained good yields are secured.

* For chemical composition and improvement of this soil see page 25.

Considerable fall plowing is done and in general up-to-date methods of cultivation are being practiced.

SUPERIOR SILT LOAM

Extent and distribution.—This type is of limited extent and is confined to a few areas in the eastern half of the county. The more important tracts are found east of Clintonville, and north and northwest from Manawa.

Description.—The surface soil of this type to a depth of from 6 to 8 inches consists of light brown friable silt loam which contains only a moderate amount of organic matter. In some of the lower locations the surface contains more organic matter than the average and here the color is somewhat darker than usual. The subsoil consists of a light reddish to pinkish red heavy compact clay loam which extend to a depth of over 3 feet. On drying large cracks are formed in both soil and subsoil, especially in uncultivated places, and a section of the soil shows light colored streaks which were crevices into which some of the surface silt was washed. This soil is quite uniform, and closely resembles the clay loam type. The chief difference being the surface soil is somewhat more silty in character.

Topography and drainage.—The surface is level to very gently undulating, and because of the heavy nature of the subsoil the natural drainage is deficient. Where the type borders the rolling phase of Superior soils into which it grades very gradually it is frequently difficult to establish a boundary line, since the only difference between is in topography.

Origin.—In origin this type is identical with the Superior clay loam, having been deposited in quiet waters, probably during interglacial time and then having been modified to a limited extent by glacial action.

Native vegetation.—The original timber consisted of hickory, elm, oak with some ash and willow in the wettest places.

*Present agricultural development.**—Most of this soil is cleared and being used for some agricultural purpose. Where drained it is mostly cultivated and excellent crops are usually secured. Where not drained it is used chiefly for hay or pasture for which it is very well suited. When properly drained this is an excellent soil and well adapted to general farming

* For chemical composition and improvement of this soil see page 25.

and dairying. The chief crops grown are small grains, corn and hay.

SUPERIOR SILT LOAM, ROLLING PHASE

This type is of limited extent and therefore of minor importance. The largest tracts occur southeast and southwest from Marion and north of Manawa.

The surface soil of this soil to a depth of about 8 inches consists of a brown or light brown silt loam which contains only a moderate amount of organic matter. This is underlain by a grayish silt loam or silty clay loam which at 14 to 16 inches is underlain by the typical pinkish-red heavy clay which is characteristic of the Superior soils. This extends to a depth usually much greater than 3 feet, though frequently in the lower portion of the 3 foot section there may be thin layers of fine sand. A lighter color may also mark the heavy clay at this depth. The soil as a whole is quite uniform. The amount of stoniness is variable however. Some areas being entirely stone free, while some have quite a number of bowlders upon the surface.

The surface of this soil is gently rolling to rolling and the surface drainage is usually good. Along some of the lower slopes where the type adjoins lower lands there are small areas deficient in drainage.

The original timber was the same as on the loam and fine sandy loam types of this series. Most of the merchantable timber has been removed and the land placed under cultivation. Most of the land is well improved, and it is an excellent soil. It is easier to work than a clay loam but sufficiently heavy to retain moisture well and also the fertilizing material which may be applied to it. The same crops are grown as on the loam soil, the same methods are followed, and the same line of improvement will apply.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR CLAY LOAM, SUPERIOR SILT LOAM AND SUPERIOR SILT LOAM, ROLLING PHASE

The chemical analyses of the Superior silt loam and clay loam soils show that their phosphorous content is somewhat lower than the average of other silt loams and clay loams in the State, while the potassium content is considerably larger. Their con-

tent of organic matter is somewhat below the average of soils of this texture. In regard to lime they vary within very wide limits, in some sections being acid, while in others they contain as high as 10 to 12 per cent of lime carbonate.

Phosphorus.—The comparatively small total amount of phosphorus contained in these soils together with the relatively large amount of iron oxide renders this element somewhat unavailable to growing crops and makes it important that farmers operating on this type of soil see to it that the available supplies of this element are maintained or increased either through the use of feeding stuffs high in this element or the purchase of sufficient phosphate fertilizers. Experiments on this soil at Ashland showed a large increase through the use of phosphate fertilizers in addition to manure. The following table gives the results of some of these experiments.

Crop	10 tons manure only		10 tons manure and 1000 lbs rock phosphate		Per cent of increase
Potatoes	87	bu. per A	128	bu.	47
Rutabagas	108	bu. per A	137	bu.	27
Corn	30.4	bu. per A	36.8	bu.	21
Clover hay	2223	pounds	3177	pounds	43
Clover seed	217.5	pounds	336.7	pounds	47

The importance of having sufficient supplies of this element is made still greater by the relatively poor drainage which the Superior clay loam has and its consequent tendency to be cold so that crops are slow in maturing. The element phosphorus is particularly helpful in hastening the maturity of crops and the formation of seed.

Potassium.—These soils average over 50,000 pounds of this element per acre to a depth of 8 inches. This potassium, however, in the form in which it exists in the soil is not available to crops and becomes so only as a result of chemical changes which are chiefly brought about through the action of organic matter. When a good supply of active organic matter is maintained the quantity of potassium is sufficient to supply growing crops almost indefinitely and it is only in the case of fields low in organic matter or where crops using unusually large amounts of

AN IMPLEMENT FOR LIFTING AND REMOVING LARGE BOULDERS.

While these stones are undesirable, and interfere with the cultivation of the land, it is usually true that where they occur the soil itself is of good quality.

SHOWING SURFACE FEATURES TYPICAL OF THE SUPERIOR SERIES OF SOILS.

This Superior soil has a high agricultural value.

available potassium are grown that fertilizers containing this element need be used.

Nitrogen and organic matter.—Nitrogen exists in the soil almost entirely in combination with organic or vegetable matter. In this soil the vegetable matter is relatively low and should be increased. The accumulation of organic matter high in nitrogen is most readily brought about through the growth of legumes such as clover, alfalfa, or soy beans. These may either be turned under as green manuring crops in which case all of the nitrogen collected from the atmosphere is returned to the soil and made available to succeeding crops, or they may be fed to animals and the manure returned to the soil so that a portion at least of the nitrogen gathered from the atmosphere is returned to the land to add to the supply already there. Whatever system of farming is followed on this type of soil should involve a rotation one member of which is a legume.

Lime and soil acidity.—This soil was originally laid down in an extension of Lake Superior as a sediment and in this a considerable amount of lime carbonate was deposited. This water-deposited soil was then worked over by the ice during the glacial period. Since this time the lime has been dissolved out of portions of the soil to a considerable extent, but other parts, less pervious to the water or containing large amounts of lime, still retain considerable quantities of this material. As a result these soils have become acid in patches, but as a whole are not acid and the subsoil still generally contains considerable lime. This is particularly favorable to the growth of clover and alfalfa, but where sorrel or other plants show the development of acidity lime should be used especially for alfalfa.

Drainage.—Where the surface of these soils is level, as is very frequently the case the question of drainage is one of importance. Over practically all level areas tile drains could be installed to advantage. Thorough drainage will make these soils warm up earlier in the spring, insure better tilth and increased yields.

CHAPTER III.

GROUP OF LOAMS AND FINE SANDY LOAMS

KENNAN LOAM

Extent and distribution.—The Kennan loam is one of the extensive and important soils in the area. It is confined chiefly to the west half of the county, and the most extensive areas occur in the northwestern quarter of the area. Throughout the region north of Iola, Northland and Big Falls, and north to the county line, the loam is the predominating soil.

Description.—The surface soil of this type to a depth of from 10 to 12 inches consists of a brown, or grayish-brown, or buff colored loam or somewhat gritty silt loam. This is underlain by a brown compact gravelly sandy loam or sandy clay which gradually changes at from 24 to 30 inches or below into material of a much more sandy and gravelly nature. The gravelly material is frequently so plentiful in the subsoil that boring is impossible in the lower depths. Typically there are a moderate number of stones and bowlders on the surface and through the soil, but these are not so numerous as to interfere seriously with cultivation. There are marked exceptions to this rule, however, and in some cases the number of stones and bowlders is so great as to interfere seriously with cultural operations. In such cases their presence has been indicated on the map by appropriate symbols. From many fields the stones have been removed and some stone fences are seen in various parts of the area. In places there is a small amount of gravel on the surface and in the upper subsoil, but such material is most abundant in the lower subsoil. The texture of the Kennan loam is somewhat variable and frequently approaches a fine sandy loam. In fact some areas of fine sandy loam have been included where they were of limited extent and where the change of one type to another was very gradual.

Topography and drainage.—The surface of the Kennan loam varies from undulating to rolling and somewhat hilly. Al-

though this type occurs on some of the largest and highest elevations there are comparatively few steep or abrupt slopes, and by far the greater proportion of the type has such a topography as to permit the use of modern farm machinery. Where extremely steep slopes have been found, or where the surface was of a very rough or broken character, a rough phase has been indicated on the soil map. These areas are frequently very stony as well as rough. The soil within the rough phase is also subject to greater variation than typical, ranging from a fine sandy loam to a silt loam. Over the roughest areas some portions have been quite badly eroded. Because of the uneven surface features of the type as a whole, and the character of the subsoil, the natural drainage is excellent. The type contains a sufficient amount of fine material so that it retains moisture well and does not suffer from drought except during extended dry periods.

Origin.—The material forming the Kennan loam has been derived through glacial action largely from crystalline rock formations. This material in a number of cases has been carried by an ice sheet over regions where Potsdam sandstone is the underlying rock, so that the resulting soil consists of a mixture of materials from these two sources. However, the granitic rock material predominates in this soil in practically all cases. There is no limestone material present in the portion of the area where this type occurs and both soil and subsoil show varying degrees of acidity.

Native vegetation.—The original timber growth on this soil consisted of maple, birch and oak, with varying amounts of hemlock, white and Norway pine. A considerable part of the type as found in the extreme northwestern part of the county is still in timber. Where the original timber has been removed there is usually a second growth in which poplar, white birch and hazel brush are plentiful.

*Present agricultural development.**—Probably from one-third to one-half of this type has been cleared and placed under the plow. Where not extremely stony, it is one of the most desirable soils in the west part of the county, and one which has very good agricultural value. It is devoted chiefly to dairying and general farming, with potatoes as an important cash crop. The

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* For chemical composition and improvement of this soil see page 33.

type affords excellent grazing, and where the stones are most plentiful the land can be used to best advantage for this purpose. Sheep are raised to some extent, although it would seem that this industry could be materially extended. Corn is raised principally for silage, but when it matures the yield usually ranges from 40 to 60 bushels per acre. Oats yields range from 35 to 60 bushels per acre with some yields reported much higher than this. Barley usually yields from 25 to 35 bushels, and rye from 15 to 20 bushels. The hay, which consists chiefly of clover and timothy, yields from 1½ to 3 tons per acre. Alfalfa is grown to a limited extent, although special treatment of the soil is usually necessary in getting this crop started. Potatoes yield from 100 to 200 bushels per acre and are the most important cash crop grown on the type. Wheat is grown only to a limited extent but gives very satisfactory yields on this soil. Probably the most common rotation followed by farmers on this soil consists of small grain, seeded to clover and timothy,—hay being cut for two years, after which the land is plowed for corn or potatoes and then again followed by small grain. Stable manure is the only fertilizer used to any extent though a small amount of green manuring is practiced.

KENNAN FINE SANDY LOAM

Extent and distribution.—The Kennan fine sandy loam is an important type though not fully improved. It is confined almost entirely to the western half of the county, and chiefly to the northwestern quarter of the area where it occurs in tracts of from 10 or 20 acres to several square miles.

Description.—The surface soil of this type to an average depth of 8 inches is brown or slightly grayish-brown, mellow, fine sandy loam. This material becomes somewhat lighter in color with depth and becomes a yellowish-brown at a depth of from 10 to 18 inches. In texture the subsoil is usually a fine sandy loam containing considerable clay which in places becomes a sandy clay loam. The heaviest portion of the subsoil usually occurs at a depth of from 18 to 24 inches. This may sometimes extend to a depth of 30 inches, but in the lower depths the material usually becomes somewhat more sandy. In some areas the subsoil through its entire section was found to be somewhat sandy, but was not sufficiently light to be classed under another type name.

A lighter phase of this soil was found to occur 4 or 5 miles south of Big Falls where the material approaches a loamy fine sand in texture. The extent here, however, was too limited to justify a separation. The type as a whole is somewhat stony, though as typically developed these stones are not sufficiently plentiful to interfere materially with agricultural development. Where the stones are most plentiful, and where they do interfere with the cultural operations to any marked degree, their presence has been indicatd on the soil map by appropriate symbols.

Topography and drainage.—The surface of this soil is undulating to rolling with a few locations which could be classed as hilly. Modern farm machinery can be used on practically all of the type, and because of the surface features and the sandy nature of the soil the natural drainage is good. There is a sufficient amount of clay in the subsoil so that moisture is retained in a very satisfactory manner, and the type does not suffer from drought except during periods of extended dry weather.

Origin.—The material forming the Kennan fine sandy loam has been derived through glacial action chiefly from crystalline rocks though the underlying rock over a portion of the area where this type occurs is Potsdam sandstone. Material from both of these formations is found in this soil, but the crystalline material appears to predominate. There is no limestone material in this region and both soil and subsoil are found to be in an acid condition.

Native vegetation.—The original timber growth consisted chiefly of hardwoods, including maple, oak, birch and some elm. Varying amounts of hemlock, white and Norway pine were found with the original timber growth. Where the land has been cut-over and not put in farms the present growth consists largely of poplar, white birch and hazel brush.

*Present agricultural development.**—This is one of the most desirable soils of the area, although because of its irregular occurrence but few farms are made up entirely of it. A considerable proportion of this soil is under cultivation and in improved farms. The yields which are secured and the methods of farming followed are very similar to those of the Kennan loam. In fact, the type as a whole is very closely related to

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* See page 33 for chemical composition and improvement.

this soil, and the boundary line separating them is frequently an arbitrary one.

ANTIGO LOAM

This soil is of limited extent. It is found chiefly in the northwest quarter of the county northeast and west of Scandinavia, north and northwest of Iola, and north of Northland.

The surface soil of this type to an average depth of 10–12 inches consists of a brown or grayish brown loam, or light silt loam of a friable structure. This is underlain by a lighter colored compact loam or silt loam which below 14–16 inches becomes quite gritty, and at about 24 inches grades abruptly into gravel or sand, or a mixture of these materials. As in the silt loam, the depth to the underlying coarse material is variable. Frequently some gravel may occur upon the surface and through the soil section. A few granitic bowlders, probably deposited by floating ice, are also found in places, though they are not numerous.

The surface of this type is level or very nearly so, and the natural drainage is good. There are only a few small sags or potholes where the drainage is deficient.

This soil has the same origin as the silt loam and consists largely of alluvial materials deposited by glacial waters as outwash plains or as stream terraces. The parent material was chiefly crystalline rocks. No calcareous material has entered into the formation of the soil, and varying degrees of acidity prevail.

The original timber growth consisted chiefly of maple, birch, hemlock with some white and Norway pine.

Although of limited extent, this is very valuable farming land, and is highly improved. It is used for general farming purposes, and is well adapted to all general farm crops common to the region.*

ANTIGO FINE SANDY LOAM

This soil is of limited extent. One tract of about one square mile occurs 2–3 miles north of Waupaca. Another is found northeast of Big Falls along the Shawano county line. A number of other smaller patches are widely scattered throughout the county.

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* For chemical composition and improvement of this soil see page 33.

The surface of this soil to an average depth of 8 inches consists of a grayish brown fine sandy loam which becomes lighter in color with depth. At 14–16 inches a yellowish-brown color may obtain and a small percentage of clay is present. In places there is a gravel deposit at about 30 inches and a moderate amount of gravel may be distributed through the soil section. The areas found in the eastern half of the county are usually free from gravel but are underlain by fine sand instead.

The surface of this type is level, or only very slightly undulating and the natural drainage is good.

This soil consists of alluvial material deposited as outwash or valley fill. The parent material was largely crystalline rocks, but in the central and eastern parts of the county, the glacial debris contains considerable sandstone material and some of this has also entered into the formation of the Antigo fine sandy loam. No calcareous rocks have contributed to this soil, however, and both soil and subsoil are in an acid condition.

The original timber consisted of maple, birch, hemlock, and some pine.

Most of the soil is cleared and is under cultivation, but because of its being found only in small tracts, but few farms are made up entirely of this class of land. It is mostly well improved and gives good yields of all the general farm crops common to the region. It is excellent potato land and would also make fine soil for truck crops, but its location regarding markets is not such as to encourage the extensive development of this line of farming.

CHEMICAL COMPOSITION AND FERTILITY OF LOAMS AND FINE SANDY LOAMS

These soils are only a little more open in texture than the silt and clay loam types. They have a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which they contain reduces the water content of the surface somewhat so that they warm up more readily in the spring and have less tendency to bake and crack than the heavier soils. These qualities make them better adapted to such crops as corn and potatoes than are the heavier soils.

The total amount of the plant food elements, phosphorus and potassium, is nearly if not quite as large in the Kennan and

Antigo fine sandy loams as in the silt loam.* However, they have rather less organic matter and this, together with the somewhat coarser texture results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of organic matter is of the utmost importance. A high degree of fertility cannot be maintained in these soils unless about twice as large an amount of organic matter is developed in them as that which they originally have. The plowing under of legumes, such as a second crop of clover or a crop of soybeans, is the best method of securing this result. The application of phosphorus and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

The Kennan and Antigo soils were derived from rocks devoid of lime carbonates and therefore have a marked tendency to become acid. The degree of acidity is usually only slight in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of most crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is in a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in the virgin condition acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop and also to watch the growth of clover carefully from year to year, so as to begin the use of

* See page 20.

lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

These types of soils are well adapted to general farming and some special crops such as potatoes can also be grown to good advantage. These soils of intermediate texture are better adapted to potato culture than are the heavier types on the one hand or the light sandy soils on the other.

SUPERIOR LOAM

This soil is of limited extent and is confined to the eastern half of the county. Some of the type is found in the vicinity of Nicholson and other small tracts near Symco and New London.

The surface soil of this type to an average depth of 8 or 9 inches consists of a grayish-brown mellow loam which contains an appreciable amount of fine and very fine sand. This is underlain by a compact pinkish-red clay or clay loam which continues to a depth greater than 3 feet. Usually the color becomes deeper red, and the structure somewhat more plastic with depth. In places there is a small amount of gravel on the surface and mixed with the soil, but as a whole the type is quite uniform. The surface is level to undulating and the natural drainage is in most cases fair to good. Only in the lowest places is it deficient. It is better than on the clay loam and silt loam types.

The loam has the same origin as the clay loam and silt loam types, having been deposited in quiet waters and later modified to a limited extent by glacial action.

The original timber growth consisted chiefly of oaks, hickory, and some elm.

Most of this type is cleared, under cultivation, and in a high stage of development. It is an excellent soil, well suited to the general farm crops commonly grown in the region. Small grains, corn and hay are the chief crops. Potatoes are also grown, but usually only for home use. It is easier to cultivate than the clay loam, and altogether is a somewhat more desirable soil. Stable manure is practically the only fertilizer used at present, though commercial fertilizers are being considered, and experience has shown that properly used they are profi-

table. The soil responds especially well to a phosphate fertilizer.*

SUPERIOR LOAM, ROLLING PHASE

Extent and distribution.—The Superior loam rolling phase is generally associated with other soils of this series. It is confined to the eastern half of the county where it is an important soil. It is most extensive in the southeastern quarter of the county and there are also numerous areas southwest of Marion and east of Symco.

Description.—The surface of this phase to an average depth of 8 to 10 inches consists of a dark brown or grayish brown loam which is usually somewhat gritty. This material usually becomes somewhat lighter in color and more compact in the lower surface section and remains quite loamy to a depth of 14 to 16 inches. While these depths represent the average, there is some variation in this respect and the loamy material in places extends to nearly two feet. The change to the subsoil is usually quite abrupt and the heavy pinkish-red clay is generally found at 14 to 16 inches below the surface. This heavy, compact red clay extends to a depth of more than 3 feet, often times many feet—though in the lower portion of the 3 foot section it sometimes becomes lighter in color, and may contain a few thin layers of sandy material. In numerous places granitic stones and bowlders were originally found upon the surface, but in many fields these have been entirely removed. Places were seen, however, where the bowlders were still present and where they were sufficiently numerous to interfere with cultivation. Gravel and some small rock fragments are frequently present in the soil and subsoil. The gravel and stones are most plentiful along the most westerly occurrences of the type, where it borders the soils of the Kennan series. In many places extensive areas are almost entirely stone free. As a whole the material forming this soil is quite uniform, the chief variation being in the stoniness. There is an exception to this, however, in Sec. 13 and 14 Town of Caledonia where the subsoil is not red, but of a yellowish-brown color. Here the material also rests upon limestone rock which occurs within the three foot section in places. This phase is really Miami loam, but because of its limited extent it was included with the Superior.

* For chemical composition and improvement of this soil see page 43.

Topography and drainage.—The surface of the loam soil ranges from gently rolling to rolling, with a few areas which could be classed only as undulating. Because of the usual surface features the natural surface drainage is generally well established. In some of the lower places it sags, and the draws between hills the drainage is sometimes deficient, but such areas are usually of small extent. Where the type borders the level phase of Superior soils or those of the Poygan or Whitman series there is frequently a narrow strip which would be improved by tile drains. There is seldom danger of serious erosion but on unprotected fields the surface soil washes to some extent during heavy rains.

Origin.—The subsoil of the Superior loam has the same origin as the Superior clay, having been laid down as a lacustrine deposit and later influenced by glacial action. The surface soil may be in part of the same origin, but a considerable proportion of the surface soil doubtless came from crystalline rock material. Some of it, and especially the more sandy phases, probably came from sandstone rock. In a few places the surface soil shows slight acidity, but the subsoil is not acid and usually contains a considerable amount of lime carbonate.

Native vegetation.—The native timber growth on this soil consisted chiefly of maple, oak, ash, hickory, walnut, and some pine. While by far the greater proportion of the merchantable timber has been removed there are still many farm wood lots containing the original timber.

*Present agricultural development.**—A large proportion of the type is cleared and under cultivation and it is one of the best soils for general agriculture within the county. All of the crops common to the region are grown successfully upon it but the chief type of farming is general farming with dairying as the chief branch. Small grains, corn and hay are grown most extensively. While most of the hay is clover and timothy, alfalfa is coming to be an important crop and is being grown with success on many farms. Potatoes are grown for home use on all farms and on a number commercially. The most common crop rotation consists of small grain, hay, corn, to which may be added a year of pasture after one or two years of hay, making a four or five year rotation. Stable manure is the chief

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* For chemical composition and improvement of this soil see page 43.

fertilizer used though commercial fertilizers are now being tried by some farmers with marked success.

SUPERIOR FINE SANDY LOAM

Extent and distribution.—This soil is found in scattered areas in the eastern half of the county associated with other types of the Superior series. Of the larger developments may be mentioned the one north from Bear Creek, and those between Clintonville and Embarrass. The total extent of the type is comparatively small.

Description.—The surface soil of this type to a depth of 10 inches consists of a grayish brown fine to very fine sandy loam, containing a moderate amount of organic matter. In low places the surface is darker than typical owing to a greater accumulation of vegetable matter. The subsoil consists of a pinkish-red clay loam which may extend without change to over 3 feet, though frequently fine sand is encountered at about 30 inches. In the lower depths the color is also lighter. The depth of the surface soil over the clay is variable and may range from 6 inches to 16 or 18 inches.

Topography and drainage.—The surface of the Superior fine sandy loam is level to undulating and except in the lowest places the natural drainage is fair to good. In the depressions or level tracts it is sometimes deficient.

Origin.—The subsoil of this type has the same origin as the remainder of the Superior types, but the surface has doubtless been influenced to a greater extent by glacial action than has the heavy clay subsoil.

Native vegetation.—The original timber consisted chiefly of maple, elm, oaks, birch and some poplar, with now and then a white pine.

*Present agricultural development.**—The greater part of this type has been brought under cultivation. The lowest and more poorly drained portions are devoted chiefly to hay and pasture, but on the remainder of the type good yields of the general farm crops are secured. The soil is not difficult to cultivate and a good mellow seed bed can be readily secured. Corn, small grain, hay and potatoes are the most important crops. This type is much better adapted to potato growing than the

heavier soils of this series. Alfalfa is grown in some localities with good success.

SUPERIOR FINE SANDY LOAM, ROLLING PHASE

Extent and distribution.—This soil is confined almost entirely to the eastern half of the county where it occurs in numerous tracts of from less than one mile to 3 to 5 square miles in extent. Its continuity is broken by other soils of this series and also by tracts of peat and soils of the Antigo series.

Description.—The surface soil of this phase to a depth of about 10 inches consists of a grayish-brown fine sandy loam. In a few places the material approaches a fine sand in texture. The lower portion of the soil section becomes somewhat lighter in color, due to the smaller amount of organic matter present. The subsoil usually begins quite abruptly and consists of a pinkish-red compact clay or clay loam. This usually extends to a depth much greater than 3 feet, though in the lower portion of the 3 foot section it is quite common to find thin layers of fine sand. The color of the clay is often lighter at this depth. A small amount of gravel sometimes occurs upon the surface and small rock fragments may be found through the soil section. Granitic bowlders are also quite plentiful upon the surface, and in places are sufficiently numerous to interfere with cultural operations. In many fields these have been removed and placed in piles along the fence rows. Much of the type is practically stone free. The depth to clay is variable but seldom exceeds two feet.

Topography and drainage.—The surface of this soil ranges from gently sloping to gently rolling and in some cases rolling. Because of the uneven surface features the natural drainage is well established. In no place is the type too broken to permit the growth of cultivated crops. Erosion is not a serious problem, though on the more rolling areas there is some danger of washing when the fields are bare, especially during the heavy rains of spring, when the ground is saturated with water.

Origin.—In origin the subsoil has the same source as other Superior soils, having been first laid down as a lacustrine deposit probably during interglacial times and later influenced to a greater or less extent by glacial action. The surface sandy

* For chemical composition and improvement of this soil see page 43.

material probably comes largely from crystalline and sandstone glacial debris. Most of the gravel, stones and bowlders associated with this soil are largely of crystalline rock origin. The surface soil is frequently slightly acid, but the red clay subsoil is not acid and usually contains considerable carbonate of lime.

Native vegetation.—The original timber growth on the soil consisted of maple, oak, elm, hickory, some walnut and varying amounts of pine. Most of the merchantable timber has been removed, though there are numerous farm wood lots in which there is still valuable timber. No extensive tracts of native forest, however, are found on this soil at present.

*Present agricultural development.**—By far the greater proportion of this soil is cleared, under cultivation, and highly improved. It is devoted chiefly to general farming and dairying, and practically all of the crops common to the region are grown upon it. It is an excellent general farming soil, and some of the most highly improved farms of the region are found upon it. The surface soil is sufficiently sandy to make cultivation easy, while the subsoil is heavy so that moisture, and fertility is retained. The surface is uneven enough to insure good drainage, but never too steep to permit the use of modern farm machinry. It occurs in good sized tracts so that many farms are located entirely upon this one soil type. The crops grown are corn, oats, barley, rye, wheat, clover, timothy, alfalfa, potatoes, and other root crops. In addition some truck crops are also grown, but the trucking industry has not been developed on a commercial scale in any part of the county, although this soil is well suited to the growing of trucking crops.

The general methods of farming followed are usually such as tend to gradually improve the soil, but there is still considerable room for improvement along these lines. The rotation most commonly followed consists of corn, small grain, and hay. The field usually being left in hay for two years, and possibly pastured for a year in addition, making a four or five year rotation. Stable manure is the chief fertilizer used, though a number of farmers have started the use of commercial fertilizers with very good results. The supply of stable manure is seldom sufficient to meet the needs of the soil, and the use of commercial fertilizers to supplement this supply is advisable.

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* See page 43 for chemical composition and improvement.

SUPERIOR SANDY LOAM

This soil is of rather limited extent, covering a total area of of about 4 square miles. It is confined chiefly to the southeastern portion of the area south and southeast from Fremont. Some of this soil is also found north of Weyauwega, and a few scattered areas occur farther north in the interior of the county. The type is usually associated with areas of Superior clay loam.

The surface soil of this type to a depth of 10 to 12 inches consists of a brown or grayish brown loamy sand to light sandy loam. Below this there is usually a few inches of light brown or yellowish loamy sand which is underlain at about 18 inches by a dense, compact pinkish red clay, which extends to 36 inches or more. In some places there is a substratum of yellowish sand, usually water saturated, at about 30 inches. The depth of the sandy material over the clay subsoil is quite variable but the heavy subsoil is always found at 2 feet or less.

The surface is level or gently undulating, and except for a few sags the drainage is fair to good.

The original timber consisted of oaks, maple, birch, some elm and in the wettest places a few willows. Some pine also grew on this soil.

This is a valuable soil for general farming, and most of the crops common to the region are successfully grown upon it. Where drainage is thorough it is a first class potato soil. It is easy to cultivate, and retains moisture well. Where shipping facilities are convenient this soil could well be utilized for more intensive farming operations, since its light surface texture places it in the class of trucking soils.

SUPERIOR SANDY LOAM, ROLLING PHASE

Extent and distribution.—This soil is of limited extent and is confined chiefly to the southern and southeastern portions of the county where it is associated with other types of the Superior series. It is frequently found adjacent to Antigo soils. Of the more important tracts may be mentioned that just south of Weyauwega and that in the vicinity of Readfield. A few smaller tracts are found in the interior of the county.

Description.—The surface soil of this phase to an average depth of 10 inches consists of a rather loose, brown sandy loam, which in places becomes as light as a loamy sand. This is usually underlain by a lighter colored sand or loamy sand for several inches and this in turn grades quite abruptly into the heavy red or pinkish red clay characteristic of the Superior series. A small amount of gravel may be found on the surface and in some localities granitic bowlders occur, though seldom in sufficient numbers to interfere with farming operations. The depth of sandy material over the clay is somewhat variable, but is seldom over 2 feet deep. The amount of organic matter in the surface soil is rather low, except in some of the lower places where a more moist condition has favored the development of more natural vegetation.

Topography and drainage.—The surface soil varies from gently rolling to rolling, and in a few places it is rather hilly. Because of the eneven surface the natural drainage is good.

Origin.—The subsoil of this type is lacustrine in origin and since its finest deposition has been influenced by glacial action. The surface material is doubtless largely of glacial origin in part from sandstone rocks and in part from crystalline rocks. The surface soil is usually slightly acid, but the subsoil is not acid and usually contains considerable lime carbonate.

Native vegetation.—The original timber consisted chiefly of oaks, maple, hickory with some pine in places.

*Present agricultural development.**—Approximately half of the type is being cultivated at present, the remainder being in second growth timber or in pasture. This is a good soil and while devoted chiefly to general farming it is doubtless better adapted to trucking crops and a more intensive system of farming. All crops common to the region are grown, and corn, for example usually does better than on the heavier types because it gets an earlier start in the spring. The soil is easy to cultivate and responds readily to soil improvements. While stable manure is about the only fertilizer now used, commercial fertilizers can be used with profit, and farmers should look into the merits of such fertilizers.

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* See page 43 for chemical composition and improvement.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SUPERIOR LOAM, FINE SANDY LOAM, AND SANDY LOAM

These soils are more open in texture than the group of heavy soils. They have a water holding capacity which is sufficient to insure good pasture, where the land is in grasses. Because of the more rolling surface, and the higher content of fine sand in the surface soil, the natural drainage is better than on the heavy level lands and the soil thus warms up earlier in the spring and does not have the tendency to bake and crack which is characteristic of some of the heavier soils. These qualities make these types better adapted to such crops as corn and potatoes, and also to the growing of fruit.

The total amount of the plant food elements phosphorus and potassium is nearly but not quite as large in the loams and fine sandy loams, as in the group of heavy soils previously described. The amount of organic matter is somewhat smaller, as is also the supply of nitrogen. Because of this and the coarser texture the rate of chemical change may not always be as rapid as in the heavier soils. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or commercial fertilizer becomes more important, especially when crops are grown which are sold from the farm.

An increase of the supply of organic matter in these soils is of great importance. It is desirable to have nearly twice as much organic matter in the soil as these types now contain. The plowing under of legumes, such as the second crop of clover, or a crop of soy beans is a good way of securing this result. The supply of stable maure is usually too limited to meet the needs of the entire farm.

As in the group of heavy soils in this county, and as is quite common in most of the state the phosphorus content of these soils is below normal, and should be increased. Even the use of stable manure will not itself supply the amount of phosphorus needed, and it is a good plan to supplement the use of stable manure with a phosphate fertilizer. Acid phosphate is the most quickly available and under present conditions is doubtless the most profitable form to use. This may be applied with small grain which is seeded to clover and about 250 to 300 pounds per acre should be used. When used with corn it may be drilled in

the row with a fertilizer attachment to a corn planter or drilled in with a regular lime and fertilizer sower just before the corn is planted.

Where general farming is followed and it is desired to build up the organic matter supply the following rotation is a good one to use:—Corn or a cultivated crop one year, followed by a small grain with which clover is seeded, the first crop the following year cut for hay, and the second plowed down as a green manuring crop to be again used for a cultivated crop. When commercial fertilizer is used it may be applied with the small grain or to the corn crop. Where a second crop of clover is not turned down it should be fed and the manure returned to the field in as liberal amounts as can be secured.

The growing of alfalfa should be greatly extended on these soils and every farmer should consider the question of starting a small acreage.

CHAPTER IV.

GROUP OF SANDY LOAMS AND FINE SANDS

PLAINFIELD FINE SAND

The type is of limited extent and is confined chiefly to the eastern half of the county where it is often associated with Coloma fine sand.

The surface soil of this type to a depth of 6 to 8 inches consists of a brown or yellowish brown fine sand underlain by a yellow fine sand to a depth of over 3 feet. Quite a few gravel stones are sometimes found. The type is usually free from gravel as well as stones. Some deep well borings show red clay and it is possible that most of the type may be underlain by such material.

The surface is level or very gently undulating and where the watertable is not close to the surface, the natural drainage is excessive.

The Plainfield fine sand is of alluvial origin and has been deposited as outwash plains or valley fill. A large proportion of it came from glaciated sandstone material though there is some crystalline material also mixed in.

The native timber growth consisted chiefly of oak and white pine with some poplar.

A large proportion of this type is being cultivated, but because of its limited extent and low agricultural value, it can be classed with the soils of minor importance.

General farm crops are grown and cucumbers and buckwheat are also raised to some extent. Dairying is the leading industry.

As with the other Plainfield sandy types, the soil is deficient in organic matter and mineral plant foods. These must be supplied if marked increased yields are to be secured.*

* See page 50 for chemical composition.

PLAINFIELD SANDY LOAM

The largest continuous area of this type of several square miles is found west of Waupaca. Other smaller tracts occur in various parts of the county, though chiefly in the western half associated with the soils of the Kennan series. The small patches which occur in the eastern part of the county contain less gravel than the western areas.

The surface of this type to an average depth of 8 to 10 inches consists of a brown or slightly dark brown sandy loam of medium texture. This is underlain by a yellowish brown sandy loam or a yellowish loamy sand which at from 18 to 24 inches contains a sufficient amount of clay to make the material somewhat sticky when wet. Gravel stones are often sufficiently nunumerous in the subsoil to make boring difficult. Gravel is also found in places on the surface, and bordering some of the areas bowlders are quite plentiful.

The surface of this type is level or nearly so, and because of the coarse material present, the natural drainage is frequently excessive; though the type is not as subject to drought as is the plainfield sand. The small amount of clay in the subsoil greatly assists in retaining moisture.

The Plainfield sandy loam has the same origin as the other soils of the Plainfield series, consisting of alluvial material deposited as outwash plains and valley fill by glacial waters. The parent material was both crystalline rock and sandstone drift and the soil is a mixture from these two sources. No calcareous material is present and both soil and subsoil are acid.

The original timber was chiefly oaks and white pine. All merchantable timber has been cut.

Probably about 75% of this soil has been improved. All the general farm crops common to the region are grown in connection with dairying farming. Rye does well on this soil, but other small grains do not yield as well as on the heavier types. Corn and potatoes yield better than on the sand, and clover can be raised with less difficulty. Some alfalfa is being grown, but liming is necessary to secure and maintain a good stand.*

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* See page 50 for chemical composition and improvement.

COLOMA FINE SAND

Extent and distribution.—While by far the greater portion of the material included in this type is fine in texture, there is a marked variation to this in some of the areas to the east of Clintonville. In these areas, the soil and subsoil both consist of very fine sand. Because of its extreme fineness and the presence of organic matter, these areas approach in value the fine sandy loam. The chief areas of very fine sand are found in T. 25 N. R. 15 E. in Section Nos. 14, 15, 21, 22, 23, 24, 25, 26, 27, 34, 35, and 36.

The Coloma fine sand is confined to the eastern part of the county. The areas east of White Lake, south of New London, and those about 5 miles east of Clintonville are the most extensive.

Description.—The surface soil of this type to an average depth of 6 inches consists of a brownish-yellow, loose, fine sand which contains only a limited amount of organic matter. The surface two or three inches has a somewhat darker color than the material immediately below this depth. This is due to the larger amount of organic matter near the surface.

The subsoil consists of a loose yellow fine sand which extends to a depth of at least 36 inches, and usually to a much greater depth. In a few instances, traces of red clay were found a little below three feet. This is the same material which makes up the subsoil of the Superior soils.

Topography and drainage.—The soil has a gently rolling surface which in a few places becomes nearly hilly. It usually occupies the most elevated positions and is thus exposed to prevailing winds. Where the surface is not protected the material is sometimes blown by the wind into dunes. In a few places wind action has rendered this soil unfit for cultivation. Such places, however, are of limited area.

Because of the loose open character of this soil and the surface features, the natural drainage is very thorough and in places somewhat excessive.

Origin.—This soil has been derived largely from glaciated sandstone material. No limestone has entered into its formation, and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber growth consisted chiefly of scrubby white and black oak, poplar, and pine.

*Present agricultural development.**—Approximately 75% of this soil is cleared and used for some agricultural purpose. The range of crops grown is more limited than in the heavier soils. Corn and potatoes are grown most extensively, but average yields are low. Clover and grasses do not do well. Small grains are grown, but yields are low. Rye is the most important grain. Buckwheat is a crop of minor importance. Cucumbers are grown in places and frequently produce very satisfac-satisfactory yields.

VILAS SANDY LOAM

Extent and distribution.—The Vilas sandy loam is confined chiefly to the northwestern quarter of the county. It occurs mostly in irregular areas seldom greater than one or two square miles in extent. Some of the more important tracts are found in the vicinity of North Lake and in the stretch of country between Ogdensburg and Big Falls.

Description.—The surface soil of the Vilas sandy loam to an average depth of about 12 inches consists of a brown or grayish-brown sandy loam or a loamy sand of a rather loose and open structure. This grades into a light brown or yellowish loamy sand which at about 24 inches grades into a gritty sandy clay or sometimes into a light clay loam. Quite frequently this heavy material is in the form of a layer of from 6 to 10 inches in thickness, below which sandy material is again found. In a few instances this heavier layer was entirely absent or only a few inches in thickness. A small amount of gravel is sometimes found upon the surface and mixed with both soil and subsoil. As is the case with the Vilas sand, the sandy loam frequently has upon the surface a number of stones and bowlders. Wherever these are found in sufficient numbers so as to interfere with farming operations to any marked extent they have been indicated on the map by means of appropriate symbols. Over most of the type they are not sufficiently numerous to detract from the value of the land.

There is some variation in the type and in a few cases it approaches a fine sandy loam in texture.

Topography and drainage.—The surface of the Vilas sandy loam ranges from gently rolling to rolling and hilly. The type

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* For chemical composition and improvement see page 50.

quite frequently occurs as ridges, some of which are quite pronounced. In some instances the slopes are extremely steep, quite frequently eroded and often stony. These extremely rough areas have been indicated on the map separately and referred to as a rough phase. The soil within the rough areas is usually subject to more variation than the typical soil. The topography of the typical soil is such that modern farm machinery can be used on practically all of the areas. On the rough phase this is difficult and it is often impossible to use modern farm machinery.

On account of the irregular surface features and the rather open character of the subsoil the natural drainage is well established and often excessive.

Origin.—This type of soil has practically the same origin as the Vilas sand having been derived through glacial action from crystalline rock material mixed with debris from sandstone rocks. It is probable that the sandy loam however, contains a somewhat larger proportion of material derived from the granitic rocks than is the case with the sand type. No limestone material has entered into the formation of this type, and both soil and subsoil show varying degrees of acidity.

Native vegetation.—The original timber growth consisted largely of oak with some white pine, poplar, birch and a small amount of maple and elm in places. At the present time the cut-over sections which are not cultivated have a second growth of poplar, scrubby oak, hazel brush, and some sweet fern.

Present agricultural development.—Probably somewhat over half of this soil is under cultivation at present, and where improed and where fair methods are followed, usually quite satisfactory returns are secured. Dairying and potato raising are the chief lines of farming. Somewhat better yields are secured than on the sand type. Potatoes are better adapted to this soil than to the Vilas sand, and the type is more readily improved. The most common rotation followed consists of a small grain, followed by clover, and then by corn or potatoes. Some difficulty is experienced in getting stands of clover—one reason being that the soil is acid and needs lime. In a few cases this has been supplied with good results, but on most of the farms no lime has ever been used.

CHEMICAL COMPOSITION AND FERTILITY OF FINE SANDS AND SANDY LOAMS

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn and potatoes, find sufficient moisture during average seasons and suffer from drought only during periods of relatively low rainfall.

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds in all types except the Vilas sandy loam which contains on an average about 1,150 pounds in the surface 8 inches per acre, or from 25 to 40 per cent more than the other types. The total potassium of the surface 8 inches per acre is approximately 25,000 pounds or but little over one-half of that found in heavier soils such as the Kennan silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface 8 inches and from 1 to 2 per cent in the second 8 inches. They have a correspondingly low nitrogen content averaging from a thousand to 1,500 pounds in the surface 8 inches and from 500 to 800 pounds in the second 8 inches. This organic matter is largely in the form of leaf-mold and fine roots and is hence of an active character so that it decomposes quickly when the surface is first broken, furnishing a sufficient supply of nitrogen for a good growth of crops for a few years. It however, is exhausted with comparative readiness and the most important point in the management of all of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases and for the best growth of clover and especially alfalfa liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover but assists in preventing the leaching of phosphorus and maintaining it in a form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown and on whether or not stock is maintained to which the produce of the

farm is fed. When dairying or other live stock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soybeans or clover, occasionally, all of which is to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necessary to maintain the soil fertility. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover and there is little loss in so doing, since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The use of lime in some form and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils it must not be considered that this is an indication that they have less value, than heavier soils which are relatievly higher in these elements, for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts and the finer tilth which these fine sands and sandy loams develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops.

From the above it will be seen that by the use of lime, by increasing the organic matter in the soil, and by the careful use

of commercial fertilizers containing phosphorus, these sandy soils may be improved and made to produce profitable crops.

For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletin 204 and 230 of the Experiment Station.

CHAPTER V.

GROUP OF SAND SOILS

PLAINFIELD SAND

Extent and distribution.—The Plainfield sand is quite an extensive soil. The principal development of the type is found in the southwestern part of the county in the Town of Dayton. It is found in other smaller areas in various other parts of the county, but mostly in the western half. In the northeastern portion this soil is found in the vicinity of Embarrass and along the Pigeon River between Clintonville and Marion.

Description.—The surface of Plainfield sand to an average depth of 8 to 12 inches consists of a loose, rather open sand of medium texture. It has a grayish-brown or yellowish-brown color at the surface, indicating a low content of organic matter. The upper subsoil is often a rusty brown grading into a yellow or light yellow sand which frequently contain a small amount of fine gravel. Gravel and a few small stones are sometimes found in and on the surface soil.

The chief variation in this soil is found in the areas in the eastern and northeastern parts of the county where the material contains less gravel and is frequently entirely free from both gravel and stones.

Topography and drainage.—The surface of Plainfield sand is level to very slightly undulating. In a few places there are pot holes or sags, but these are always of limited area. The slight surface relief is due chiefly to wind action. A few hummocks occur which are quite pronounced sand dunes.

Because of the loose open character of the material the natural drainage is excessive except where the water table comes close to the surface.

Origin.—The soil is of alluvial origin and has been deposited as outwash plains and stream terraces. The material has been derived both from crystalline and from sandstone glacial drift. In the western and north central portions of the county the dark colored crystalline grains are quite numerous; while in the

eastern part there is a larger proportion of quartz grains. There is no calcareous material present and both soil and subsoil show varying degrees of acidity.

Native vegetation.—The original timber growth consisted of scrub oak, jack pine, and white pine with hazel brush and sweet fern quite abundant. Most of the type has been cleared and placed under cultivation, but because of its low productiveness and droughty condition, some farms have been abandoned. It is not uncommon for fields to remain idle for several years at a time.

*Present agricultural development.**—Probably 75% of this type is under cultivation more or less regularly and while there are some highly improved prosperous farms located upon it, there are more farms that are in a depleted state. The chief crops grown are potatoes, rye, corn and hay. Clover does not do well unless special attention is given to it. Rye does better than other small grains but average yields are low.

Potatoes are the chief cash crop, and a considerable acreage is grown on nearly every farm each year. Some dairying is carried on, and this is a good system for building up the soil, but the difficulty of securing good yields of forage crops gives this soil a handicap in the dairy industry.

VILAS SAND

Extent and distribution.—The Vilas sand is found most extensively in the southwest quarter of Waupaca County. The most extensive areas are found in Dayton Township and in the southern part of Farrington Township. Smaller areas occur in the northwestern portion of the county, chiefly in the vicinity south of Big Falls. Smaller and less important areas are found throughout the western half of the county.

Description.—The surface soil of the Vilas sand to an average depth of about 8 inches consists of a brown or grayish-brown sand or slightly loamy sand of medium texture. In structure the material is usually loose and open. In some small areas the texture approaches a fine sand, while in others the soil is somewhat loamy, but these variations are not of sufficient extent to be mapped separately. In places the virgin soil is slightly darker than usual in the surface 1 or 2 inches because of the ac-

* See page 56 for chemical composition and improvement.

SHOWING ROLLING SURFACE OF VILAS SAND.

While erosion is usually not a serious problem on sandy soils, these fields, being somewhat steeper than the average, have washed badly. This is due chiefly to furrows which ran up and down the slope along the edge of the fields. The surface water, during heavy rains collected in these furrows and soon cut deep channels. With a little care this could have been prevented. Furrows should be run with the contour of the hills.

SHOWING TYPICAL LEVEL SURFACE OF PLAINFIELD SAND.

This soil is loose and open in structure, somewhat droughty and deficient in both nitrogen and the mineral plant foods. With proper methods of fertilization and cultivation, however, it can be made to produce fair crops as indicated in this view.

cumulation of a small amount of organic matter. After a few years of cultivation, howeevr, this usually disappears. The subsoil consists of a yellow or yellowish-brown sand of about medium texture. This very frequently becomes lighter in color and coarser in texture with increase in depth. In some instances gravel may occur sparingly on the surface, but it is usually more abundant in the subsoil below a depth of 24 inches.

Stones and bowlders of glacial origin are quite commonly found scattered over the surface of this soil, but typically these are not sufficiently numerous to interfere materially with cultivation. In some localities, however, they do interfere with agricultural operations to a marked extent. Such areas are indicated on the soil map by means of appropriate symbols. Where the soil is stony there is frequently more variation in texture than over typical areas of this soil.

Topography and drainage.—The surface of the Vilas sand varies from gently rolling to somewhat hilly. Most of the slopes are rather gentle and the hills fairly well rounded. Many areas have but a gently rolling topography. In the southwestern part of the county many of the areas of Vilas sand stand out in rather sharp contrast to the surrounding level country where the soils belong to the Plainfield series. Because of the surface features and the loose, open character of the soil and subsoil, the natural drainage is very good and often somewhat excessive.

Origin.—Vilas sand has been derived from glacial action largely from crystalline rock formations, although the underlying rock where much of the type occurs now consists of sandstone. The ice sheet in its movement carried the material from the region of the granitic rocks out over the standstone area so that the resulting soil consists of a mixture of the materials from these two sources. Crystalline rock material, however, appears to predominate. No limestone material has entered into the formation of this soil and it is all in an acid condition.

Native vegetation.—The original timber growth on this land consisted of scrubby oak, and some white pine. In the areas toward the northern part of the county some Norway pine was found, and in a few instances hickory has been found growing on this soil. The chief growth at present consists of scrubby oak, hazel and sweet fern.

*Present agricultural development.**—Probably less than half

* For chemical composition and improvement of this soil see page 56.

of the Vilas sand is under cultivation at the present time. Where cleared and under cultivation general farming, dairying and potato raising are the usual lines followed. Potatoes are the most important cash crop and yield from 75 to about 125 bushels to the acre with occasional yields which are somewhat higher where special and improved methods have been followed. Corn yields from 15 to 35 bushels, oats from 15 to 30 bushels, rye from 10 to 15 bushels, and hay from ½ to ¾ tons per acre. It is somewhat difficult to get a good stand of clover on this soil and timothy does not succeed very well. The yields on this soil depend to a considerable extent upon the amount and distribution of rainfall and the manure or organic matter applied to the soil. The type is quite easily exhausted by continuous or improper cropping, and the methods followed are usually not those best suited to building up the productiveness of the land.

CHEMICAL COMPOSITION AND FERTILITY OF SAND SOILS

In some respects sandy soils have advantages over heavier soils. They become drier and therefore warmer and can be worked earlier in the spring and more quickly after rains than heavier soils. These advantages are particularly important in regions of short growing periods. But when the soil is too sandy it does not hold sufficient water from one rainfall to another to satisfy the needs of the growing crops and they therefore suffer from drought. Moreover, sandy soils are lower in their supply of the chemical elements demanded by crops than heavier soils. When these two factors become too low they limit the profitable farming of these soils. In the mapping of the Soil Survey those soils which are classed as fine sands or sandy loams have fairly good water-holding capacity, and when their fertility is properly maintained their good qualities in regard to warmth and earliness can be taken advantage of and they can be farmed with profit. But soils which are classified as sands, such as the Coloma and Plainfield sands, are so coarse as a rule that they do not have sufficient water-holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grain.

The chief factor limiting their agricultural use is that of water-holding capacity. This depends chiefly on the texture or

fineness of grain and cannot be affected by any treatment it is practicable to give them. The water-holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparatively slow process and the amount of organic matter it is practicable to develop and maintain in these soils will increase their water-holding capacity only to a limited extent.

The total content of the essential elements of plant food in these soils is moderate. The total phosphorus in the surface 8 inches per acre averages between 750 and 900 pounds and in the second 8 inches between 600 and 700 pounds. The total potassium in the surface 8 inches per acre is about 25,000 pounds in comparison with 50,000 or 55,000 pounds in the silt loam soils of that region. The total nitrogen content is between 1,200 and 1,400 pounds in the surface 8 inches per acre.

When a sufficient supply of active organic matter is developed in these soils a considerable portion of the phosphorus and potassium will undoubtedly be made available, but the use of fertilizers containing these elements in a more readily available form is desirable whenever these soils are farmed.

The starting point in the improvement of these soils is the development of active organic matter through the growth of legumes which are able to secure their nitrogen supply from the atmosphere. But before legumes can be grown with the greatest success the liming of the soil is necessary. The growth of a good crop of mammoth clover or soybeans through the use of lime and mineral fertilizers containing phosphorus and potassium is the best means of supplying this nitrogen and organic matter. In most cases this legume should be plowed under as a green manuring crop.

Probably the best way to get clover started is to seed with a small grain. By using a light seeding of rye, disked or harrowed in and seeded to clover in the spring, a good stand can usually be secured. The seed should be put in a little deeper than on heavy soils, and the drill should be followed by a corrugated roller, or if this implement is not at hand, an ordinary roller, followed by a light harrow should be used. When clover is seeded with a small grain in this way the growing grain helps to hold the soil in place and prevent blowing of the loose soil by the wind.

As the result of careful experiments on extremely sandy soils it appears that the best crop rotation for this class of land con-

sists of rye, clover, and corn. If the fertility is extremely low. it will be advisable to plow under the entire clover crop. If the fertility is fair the first crop may be cut for hay and the second plowed under. While potatoes are quite extensively grown on these extremely sandy soils this crop is not as well adapted to the sand soils as to sandy loam types. It has been shown by actual field tests that the yields of corn, for example, can be more readily increased on the sand soil than can the yield of potatoes. The potato when grown on sand soil does not respond to methods of soil improvement as readily as when grown on soils which contain somewhat more silt and clay. The sandy loams and fine sands and fine sandy loams are much better adapted to potato culture than are the sand soils. It is therefore advisable to reduce, where possible, the acreage of potatoes on sand soils.

With an increased acreage of corn it will be possible to put up enough silage so silage may be used for summer feeding. With this practice less pasture will be required, and this again will be desirable since the sand soils do not supply good grazing, and are not well adapted to any of the grasses. This system would make possible keeping more stock, and with the increased supply of manure the fertility of the land could be more readily maintained.

CHAPTER VI.

GROUP OF POORLY DRAINED SOILS

GENESEE FINE SANDY LOAM

Most of this soil is limited to the valley of the Wolf River where it is found at and below New London. A few other patches occur along the Little Wolf river near Manawa.

The surface soil of this type consists of a brown or dark brown fine sandy loam about 8 to 10 inches deep. Some of the surface soil is more nearly a very fine sandy loam. The subsoil is a lighter brown fine sand, somewhat loamy with frequent thin layers of red clay. In the lower depths there is usually found fine sand. The type is somewhat variable in texture, ranging from a fine sand to a loam, but these separations could not be made because of the limited extend of the phases.

The surface of the type is level, and it is all within the present flood plain of the streams along which it occurs. The natural drainage is therefore very deficient.

The material forming the soil is all of alluvial origin and has come in part from sandstone and in part from crystalline rock material,

The native timber growth consists of elm, ash, willows, coarse marsh grasses and other water loving vegetation.

Since the type is all subject to overflow only a very small part of it has been brought under cultivation. Near New London this soil is being farmed to some extent to truck crops, and good returns are secured when floods do not interfere. Most of the soil is used for pasture and for hay, to which in its present condition it is doubtless best adapted.

The danger from flooding makes farming on this land uncertain, so that the development of this type of soil is not encouraging. To prevent flooding dikes would in most cases be necessary, and such great expense would not be justified under present conditions.

GENESEE SILT LOAM

Most of this soil is associated with the fine sandy loam along the Wolf River. Often a strip of fine sandy loam lies between the silt loam and the river. The sandy soil being slightly higher than the silt loam.

The surface soil of this type to a depth of 10 inches consists of a brown or frequently dark brown rather compact silt loam. The underlying material is of a lighter brown color, in places it has a suggestion of red in it. The subsoil is usually a silt loam or silty clay loam in which lenses of fine sand sometimes occur. The deep subsoil is frequently found to be a fine sandy loam or very fine sand. The type as a whole is subject to considerable variation.

The surface of this soil is level, and as it is low and within the flood plain of streams the natural drainage is very poor. It is subject to annual flooding and in places new material is being added to it each high water.

The timber growth consists of ash, elm, willow, soft maple, coarse grasses and other water loving vegetation. In a few places attempts have been made to cultivate it but the danger of flooding prevent any extensive developments. The soil itself is very fertile and productive, and if the drainage could be perfected it would be a valuable soil. Under present conditions it would not be practicable to attempt to drain it. The use of dikes, and possibly pumping plants would be necessary which would not be justifiable under prevailing conditions.

WHITMAN SILT LOAM

Extent and distribution.—This type occurs in two distinct forms. One is as depressions, or sags in the upland, and the other is as low land bordering streams. The latter is by far the most extensive, and the largest tract of this type is found along the Wolf River just north of Fremont, in the southeastern part of the county. Smaller tracts occur along the same stream in the northeastern part of the county and also along the Embarrass River. A few scattered areas of the other phase occur throughout the remainder of the county, but these are of limited extent.

Description.—The surface soil of this type to a depth of 10 to 18 inches consists of a dark brown or black loam to silt loam

which contains a large amount of organic matter. In numerous places there is a thin layer of peat or muck over the surface of the earthy matter. This organic matter layer, however, is not sufficient to justify classing the type as peat or Muck. The subsoil consists of a black or dark brown heavy loam or silty clay loam which at from 18 to 24 inches usually becomes gray or bluish in color, with numerous yellow and rusty mottlings. In the lower portion of the 3 foot section the texture frequently becomes lighter and is often a fine or very fine sandy loam. The type is subject to considerable variation in texture, depth of the black soil over the bluish subsoil, and also in the sand layer in the deep subsoil. It is uniform however in being all rather heavy, dark colored, high in organic matter and all poorly drained, giving it all a uniformity in its present agricultural value.

Topography and drainage.—The surface of this type is level, or having only a very gentle slope toward the stream along which it occurs. The small depressed tracts frequently have a saucer shape. Because of its low position, and its situation adjacent to streams its natural drainage is very deficient. Practically all of that along streams is subject to overflow, and much of it is under water for some portion of each year.

Origin.—The portion of the type adjacent to streams is largely of alluvial origin with a large accumulation of organic matter in surface. The parent material came largely from the crystalline rock region, although within the area much of the soil lies directly over sandstone formations. The part of the type which is not adjacent to streams is largely of glacial origin and occurs chiefly in shallow potholes or slight depressions where drainage is deficient, and where there has been an accumulation of organic matter. In most cases there is no lime carbonate in the material forming this soil and the material shows varying degrees of acidity.

Native vegetation.—The native vegetation on this soil consists of willows, elm, ash, soft maple, and some poplar. There are quite extensive tracts which are treeless, and where there is now only a dense growth of coarse marsh grass.

Present agricultural development.—The chief use made of this soil is for pasture and hay, but a considerable part of it is too wet even for such use.

Chemical composition and fertility.—The Whitman silt loam is quite similar to the Clyde silt loam of southeastern Wisconsin,

differing chiefly by being acid, while the Clyde soils are not acid. From the standpoint of plant food elements which they contain these two types represent the best balanced soils in Wisconsin.

Whitman silt loam contains from 3–5 times as much nitrogen and organic matter as does the average light colored heavy soil of the same region. It contains from 1,500 to 2,000 pounds per acre of phosphorus in the surface 8 inches, and from 40,000 to 50,000 pounds of potassium.

In the improvement of this type the first step is to supply adequate drainage. Open ditches will not be sufficient by themselves, and should be supplemented by the use of tile drains. When well drained this will be one of the strongest and naturally most productive soils of the county. Because of the extremely low position the reclaiming of some of this land would require diking, which under present conditions would not be justified.

DUNNING FINE SANDY LOAM

Extent and distribution.—This soil is found rather widely distributed throughout the county, usually in small bodies and narrow strips along water courses. In but few instances does a single area exceed one square mile in extent. The soil is found most extensively in the eastern half of the county—mostly in the southeastern quarter, where it is associated with other low-lying soils along the valley of the Wolf River. Smaller tracts occur along the Embarrass River and also along smaller streams of the county.

Description.—The surface soil of this type consists of a dark brown to black fine sandy loam extending to a depth of from 8 to 12 inches. In places the texture approaches a sandy loam, while in other places it is nearly a very fine sandy loam. In all cases it contains a large amount of organic matter and there is frequently a thin covering of peaty or mucky material over the surface of the type. This is not deep enough, however, to be classed as shallow peat. The subsoil consists of a grayish, or grayish brown fine sandy loam or gritty sandy clay loam containing considerable silt in places. The deep subsoil is often mottled, especially where there is the most clay present. The texture of the type is quite variable but is always somewhat sandy, high in organic matter and low-lying.

Topography and drainage.—The surface of this type is level, it is all low lying and the natural drainage is very deficient. Much of the type is subject to overflow and portions of it are under water for a time each year.

Origin.—That portion of the type adjacent to streams is largely alluvial in origin, while that more distant from streams is largely glacial, occurring in old lake or pond beds. The parent material came in part from crystalline rock regions, and in part from sandstone formations. In most cases the material is acid.

Native vegetation.—The native vegetation consisted of elm, willows, ash, soft maple, some poplar, and coarse marsh grasses. Many areas are treeless and support only coarse grasses.

Present agricultural development.—The chief use made of this soil is for hay and pasture but much of it is too wet most of the year even for such use. In a few instances better drained parts of the type have been placed under cultivation, and during seasons of limited rainfall good crops are produced.

Chemical composition and fertility.—This soil is well supplied with nitrogen and organic matter, but is usually deficient in the mineral plant foods phosphorus and potassium. The greatest deficiency, however, is in drainage, and before cultivated crops can be grown successfully a thorough system of drains must be provided. Open ditches as now installed are not sufficient in themselves, and must be supplemented either by open laterals, or tile drains, or both. When drainage has been provided it will be found that the most economical and profitable crop production can be secured by the use of mineral fertilizers containing phosphorus and potassium. Such crops as alsike clover and timothy, buckwheat, and corn may be expected to give best results on this kind of land under good management.

POYGAN CLAY LOAM

The surface soil to a depth of 8 to 10 inches consists of a dark brown to black silty clay loam to silty clay. This is underlain by a light brown, drab, or bluish silty clay often mottled with brown and yellow. At from 14 to 20 inches the material changes to a plastic clay streaked or spotted with pinkish-red and bluish-gray. With increasing depth the reddish color becomes more pronounced until at from 20–24 inches the material becomes a dense, pinkish red clay similar to the subsoil of the Superior soils.

This type is of limited extent and occurs in many small widely scattered areas throughout the eastern half of the county. It is found mostly in small pockets or sage of less than 100 acres in extent. The largest area mapped lies north of Bear Creek.

The surface is flat or saucer shaped, and the natural drainage is poor. Water frequently stands on the surface in the spring and after heavy rains. Before it can be used for cultivated crops drainage is necessary. The material forming this soil is largely of lacustrine origin though it has doubtless been modified to some extent by glacial action. There has been accumulated at the surface a large amount of organic matter which accounts for its dark color. This soil is seldom acid, and the subsoil frequently contains considerable lime carbonate.

The native timber growth consisted of elm, ash, willow with considerable coarse grass and other water loving vegetation.

This is naturally a strong productive soil when drained, but only a very small proportion of it has been placed under cultivation. Where cleared, it is being utilized chiefly for grazing and for hay.*

POYGAN SILT LOAM

The Poygan silt loam is not an extensive type but it is found in numerous small tracts throughout the northeastern portion of the county. There is also some in the southeastern part of the area. It frequently borders marshes, and is also associated with soils of the Superior series.

The surface soil of this type to an average depth of about 12 inches consists of a dark brown or black silt loam which contains a very high proportion of organic matter. While much of the surface is a silt loam the type is somewhat variable, and many of the areas approach a loam in texture and there is also some fine sandy loam included with the type.

The subsoil consists of a gray or bluish silt loam which continues to from 24 to 30 inches where the typical red color of the Superior clay loam is found. At or near three feet, beds of sand or fine sand are frequently found. The upper portion of the subsoil is subject to some variation. It may be no heavier than a loam with which there is mixed more or less gritty material. Entire absence of the red clay was noted in places.

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* For chemical composition and improvement of this soil see page 66.

The surface of this type is low, level and naturally very poorly drained. Most of it is so situated, however, so that it can be drained by the use of tile.

The material forming this type is largely lacustrine but since its deposition there has been added to it large accumulations of organic matter through the growth and decay of a rank vegetation. Before this organic matter accumulated the material had doubtless been influenced to some extent by glacial action. The material, especially in the subsoil, is of a calcareous nature, and the type is very seldom found to be in an acid condition.

The original timber on this land consisted chiefly of elm, soft maple, ash, willows, alder, coarse grasses and other water loving vegetation.

Because of the naturally poor drainage, only a small part of this type has been placed under cultivation. It is a rich productive soil, and when thoroughly drained makes excellent farming land. Most of it is now utilized chiefly for hay and pasture.*

POYGAN FINE SANDY LOAM

The surface soil of this type consists of a black, or very dark brown fine sandy loam or loam which contains a large amount of organic matter. This usually extends to a depth of about 12 inches where the material becomes lighter in color, and usually heavier in texture. At about 18 inches a drab, gray or bluish silt loam or loam somewhat gritty is found and this continues to from 2 to 3 feet where the red clay typical of the Superior series is usually but not always found. The lower subsoil is quite variable and may be a sticky sandy loam or loam of a bluish color. In a few places it was a fine sand. It is probable however that the heavy red clay occurs beneath all of this soil, although not always within reach of the soil auger used.

This soil is of limited extent. It is found chiefly in the northeastern quarter of the county. Several small tracts occur east and west of Embarrass, three miles north of Bear Creek, and about three miles northwest of Clintonville.

The surface is level, low lying and the natural drainage very poor. It is found associated with other Poygan soils, and with types of the Superior series. It frequently occurs bordering marshes.

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* See page 66 for chemical composition and improvement of this soil.

The red subsoil has the same origin as the Superior soils, but it is probable that the sandy portion of the material may have been washed in from the higher lying lands adjoining. The dark color is of course due to the growth and decay under moist conditions of a rank vegetation.

The native timber vegetation consisted of elm, ash, willows, alder, coarse grasses and other moisture loving vegetation. But little of this soil is cleared and cultivated because of the poor drainage condition. Most of it is devoted to pasture or to hay, although some is still in timber and is not utilized at all. When thoroughly drained this will be an excellent soil for farming crops and also for numerous trucking crops, where other conditions are favorable for the developmet of intensive farming operations.

CHEMICAL COMPOSITION AND FERTILITY OF POYGAN CLAY LOAM, SILT LOAM, AND FINE SANDY LOAM

These types of soil are characterized by having relatively large amounts of organic matter, accumulated as a result of poor drainage. The supply of phosphorus in these soils is usually fairly high, but in many cases it is not readily available. Its availability will depend largely upon the rate of decomposition of the organic matter. The total amount of potassium in these soils is fair in all and large in some, but the chief question here also is in regard to its availability.

While soils well supplied with vegetable matter as these usually are, do not need special treatment with reference to potassium and phosphorus immediately after reclamation, they very generally do show a need of care in this regard within a few years, and patches of these types frequently fail to produce satisfactory crops even immediately after drainage and breaking unless barnyard manure or special mineral fertilizer is used.

In the improvement of these types the first step of course is drainage. Both open ditches and tile drains can be installed to advantage in the reclamation of these lands. Plowing fields in narrow strips with dead furrows from 2 to 4 rods apart, and having these lead into shallow open ditches along the side of the field will greatly assist in carrying off the surface water. In order to make the internal drainage of the soil complete, however, tile drains should be used to supplement the surface ditches.

With thorough drainage these soils will be adapted to a wide range of general farm crops. Special crops such as cabbage and sugar beets are well suited to these lands when drained.

PEAT

The material mapped as Peat consists of decaying vegetable matter in varying stages of decomposition with which there has been incorporated a small amount of mineral matter. Where raw and fibrous, and only slightly decomposed, the Peat has a brown color, but where more completely decayed it becomes darker and is sometimes black. It is light in weight as compared with other soils, and is loose and rather spongy. The surface material is often of a lighter brown color than that found at a depth of 2 feet or more. This is usually true of the timbered marshes. In some instances the more thoroughly decomposed material occurs at the surface and the raw fibrous peat is found at lower depths. This appears to be the case most frequently where marshes were originally treeless.

The material mapped as Peat ranges in depth from 18 inches to over 3 feet. Where less than 18 inches it has been classed as shallow peat and mapped separately. In some instances the peat is known to be over 10 feet deep. The material found beneath the peat is variable. Where the marshes are surrounded by sandy soils the peat is usually underlain by sand, and where the upland bordering the marsh is heavy the material under the marsh is usually also heavy.

Peat is an extensive soil in Waupaca county and is found in practically all parts of the county. The tracts vary in size from a few acres to several square miles. Of the most extensive areas may be mentioned one found 5 to 6 miles southwest from Clintonville, one 7 to 8 miles east of Manawa and another immediately northeast from White Lake. East of Embarrass there are also several smaller tracts. Many less important areas are scattered throughout the county. The line between the Kennan and Superior soils is frequently marked by areas of Peat.

The surface of all peat areas is low, level, water soaked, and naturally very poorly drained. Before farming operations can be carried on the Peat must be reclaimed by some system of drainage. A small proportion of the marsh land inWaupaca County has been drained more or less thoroughly by open ditches, which in some cases have been supplemented by tile drains.

Probably the most important factor in determining the value of marsh land will be the crops which can be grown upon it. This depends upon two factors, first the degree of drainage, and second the danger from frosts. When only the main outlet and lateral ditches have been installed, in the great majority of cases, hay crops are the only ones which can be safely grown, and the character of the hay will also depend a good deal on the character of the drainage. In the case of peat land underlain by sand, the drainage by well constructed and sufficiently deep ditches 40 to 80 rods apart will, in some cases give adequate drainage for hay. When the peat is underlain by silt or clay, however, ditches not more than 20 rods apart will be necessary ,and these must lower the water in the ditch to a point 4 or 5 feet below the surface during part of the growing season. When tilled crops are grown, such as corn, cabbage, or potatoes, or small grains are to be grown the drainage must be more certain, and over the larger proportion of the marsh land this will mean the installation of drainage systems in the form of either open lateral ditches or of tile not more than 10 and often not more than 5 rods apart on the average. Tile drainage is the more satisfactory. The cost of tile drainage will vary from \$40—\$80 per acre after the main outlets have been put in.

It is well known that frosts frequently occur on marsh land when there is no frost at all on the higher land adjoining. This is partly because the cold air which forms on the surface of all the ground at night tends to flow down and collect in low places, but it is also the result of the fact that the loose, spongy soil of peat marshes does not conduct the heat received from the sun during the day downward to so great an extent as do upland earthy soils. In consequence of this, the lower layers of soil do not become warmed in peat marshes as they do in other earthy soils and the little heat left in the surface inch or two is rapidly lost at night by radiation, so that he freezing point is frequently reached on such soil when it would not be on more earthy soils such as sandy loam or clay loams which would conduct the heat downward better during the day, and so keep warm farther into the night.

This difficulty with peat marshes can be overcome to a certain extent by heavy rolling which, by compacting the soil, permits the heat to be conducted downward more readily. It will also to a certain extent become less in time as the peat decom-

poses and takes on more of the character of muck. Nevertheless, it must always be expected that marsh land will be more subject to the late spring frosts and the early fall frosts than high land. It may be stated as a general guide that the occurrence of killing frosts is as liable on marsh land at any given point as it is on upland soil having good air drainage about 150 miles farther north. In other words the marshes of Dane County are as liable to have a frost which will kill corn as early as are the upland regions of Shawano, Marathon and Clark Counties. The marsh land regions of Waupaca County are as liable to have frost two weeks or more earlier than the hilltops of the same latitude. This means that corn and potatoes, while safe crops for the upland region, are not safe for the marsh land, and should not be depended on as the chief marsh land crops.

The native vegetation on the Peat marshes consisted chiefly of coarse marsh grasses, sedges, and sphagnum moss on the open marshes, with willow, alder, some poplar, and tamrack on the timbered tracts.

By far the greater portion of the Peat is still in its wild state. Some tracts have been cleared and are being utilized for hay and pasture. The hay is made from the coarse marsh grasses which have a considerable lower feeding value than the tame grasses. Wire grass from some marches is marketed for making rugs and matting. In a few instances small tracts have been reclaimed and are being used for cultivated crops. Part of the tract north from Waupaca is used for growing potatoes, cabbage, celery, onions and other garden truck. It is well suited to these crops. There is no reason why a larger proportion of the Peat lands of this county should not be reclaimed and utilized for these and other cultivated crops, as well as for hay and pasture.

Peat. Shallow Phase.—The shallow peat is not nearly so extensive as the deep peat, although it is fairly well distributed throughout the area. It often forms the border between the highland and areas of deep peat, but some tracts are made up entirely of the shallow peat.

The only difference between the two phases is that the shallow peat has a depth of 18 inches or less, while the deep peat has a greater depth—usually over three feet. Both are made up of the same material and have the same origin. As with the deep peat the subsoil is variable, and conforms quite closely

with the character of the adjoining upland. Where heavy soils border the marsh the underlying material is usually heavy, but where the upland is sandy the subsoil of the marsh is usually sandy also. There is probably somewhat more mineral matter mixed with the shallow peat, than with the deep peat, but none of the material could be classed as muck. But very little of the shallow peat is under cultivation. It is utilized to some extent for hay and pasture, but only a few small areas have been reclaimed for cultivation.

Chemical composition and fertility.—In the improvement of peat lands in Waupaca County the first step, of course, is drainage. With the exception of some of the marshes immediately along the Wolf River it is thought that much of the peat could be readily drained and successfully cultivated. Along the Wolf River the surface of the peat is so low that much of it would require diking, or a lowering of the bed of the river, which would be very expensive, and hardly justifiable under present conditions.

The chief difference between peat soils and upland soils consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorus in the peats of this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot there is approximately only 675 pounds, or in two feet 1,350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average 0.3 per cent of this element, while good upland clay loam soils average two per cent, or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3,000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent and this only in the surface eight inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and potassium. These elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat, the manure should be used on the upland soils and commercial fertilizers containing phosphorus and potassium used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will probably be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

Crops and system of farming on marsh lands.—Since the growth of corn and potatoes to which these marsh lands would otherwise be adapted, is limited in this section on account of the danger from frost, the best staple crops for this land are grasses for hay and pasture, hardy root crops. and rye, and to a less extent oats. When properly fertilized and limed, clover, alfalfa, and other legumes can also be grown. On fairly well drained marsh land not too raw good pasture can also be developed. The compacting of the soil resulting from the use of this land as pasture is also a great benefit to it. When peat land is placed under cultivation a heavy roller should be classed along with implements necessary to its successful management.

On account of the crops to which this land is adapted and its use as a pasture, marsh lands can be used for dairying or stock raising to good advantage.

Certain special crops, such as cabbage, onions, buckwheat, and rape, are well adapted to such lands when well drained and fertilized.*

* For more complete discussion of the management of marsh soils see bulletin on this subject by the Agricultural Experiment Station.

CHAPTER VII.

GENERAL AGRICULTURE OF WAUPACA COUNTY

The development of agriculture in this region was preceded by the growth of the logging and lumbering industries. The earliest settlements were made chiefly in the sandy portions of the county as the forest growth here was largely pine, which was the only timber handled by the early lumberman.

The first farming operations were started in Waupaca County in 1849 on a bit of sandy prairie in the town of Lind. The first farms, opened after the advance of the lumbermen, were small. While farming ventures were first started largely on the sandy soils following the cutting of the pine, the highest agricultural development has been reached in those sections where the soils are heavier. The earlier and more primitive types of farming have gradually developed into the present conditions of agriculture. Farming has extended into practically all parts of the county with the exception of some areas in the northwestern part which are still in a cut-over stage. Even through this section a number of farms are already in operation. By far the greater proportion of the county is well improved agriculturally.

While practically all the general farm crops now grown were produced in the early history of the county, the relative importance of a number of the crops has changed to a considerable degree. In 1879, wheat occupied 21,731 acres, which was more than twice the area devoted to oats, and nearly twice as much as was devoted to corn. In 1909 the total area devoted to wheat was only 1150 acres, while there were 38,860 acres devoted to oats and 19,948 to corn. The acreage devoted to hay, corn and potatoes has steadily increased since the early history of the county. The acreage devoted to rye and barley has changed less than that devoted to the other general farm crops. The development of the potato growing industry has been marked. In 1879, there was a total production of 250,307 bushels, while in 1909 the yield amounted to 2,392,213 bushels. In 1919 the yield was 1,907,046 bu. an average of 106 bu. per acre.

* Figures given for 1919 are from reports of assessors.

The type of farming which is followed most extensively in Waupaca County is based upon the dairy industry. In the southwestern and western parts of the county, potato raising is the leading industry in connection with dairying. In the eastern part, in the region of Superior soils, much less attention is paid to potato growing, and dairying is the leading industry. In the region of these heavier soils there are a number of farms upon which not enough potatoes are grown to supply the home table. On these heavier soils grain raising receives more attention than elsewhere.

Practically all of the crops grown at present may be considered in part as cash crops, for hay, corn, oats, rye and barley are sold to some extent directly from the farm. Potatoes are grown mainly for sale, although they are one of the most important subsistence crops. The greater part of the hay, corn, oats and barley is used in feeding life-stock, and a large proportion of it finally reaches the market in the form of dairy products, beef and pork.

Hay is grown more extensively than any other crop. In 1909 the census reports 58,286 acres in all hay crops with a production of slightly over 98,000 tons. Of the hay crops grown, by far the greater proportion consists of timothy and clover mixed. A small amount of timothy is grown alone and also a small amount of clover. There are approximately 9,500 acres from which marsh hay is cut, and the balance of the hay crop is made up of alfalfa, millet, grain which is cut for hay, and coarse forage crops. The best hay crops are produced on the heavier type of the Superior, Kennan and Antigo series. As many of the soils in the western part of the county are somewhat acid, alsike clover is sometimes grown in place of red clover. Red clover does well on land whose productiveness has been kept up, and succeeds on new land in spite of the acidity; but on run down fields which are acid, it is frequently difficult to get a good stand of clover. In 1919 there were 1248 acres of alfalfa in the county.

In 1909, the acreage devoted to oats was 38,860 acres which produced a total yield of 1,153,059 bushels. This crop does best on the fine sandy loams, loams and silt loam soils. Where it is raised on the extremely sandy soils in the southwestern part of the county, results are usually unsatisfactory. In 1919 the average was 40,781.

In 1909, corn was grown on 19,948 acres, and the total yield was 602,144 bushels. This crop is not grown as extensively as in counties to the south as the climate does not always permit the crop to mature. In 1919 there were 32413 acres in corn, about 67 percent was used for silage and the remainder was harvested for grain.

The potato crop is one of the most important, especially in the southwestern quarter of the county where sandy soils predominate. In 1909, the acreage amounted to 19,810 acres and the total yield 2,392,213 bushels. While the greater proportion of the crop is grown in the extremely sandy sections, the best yields are obtained where there is a sufficient amount of clay in the soil to make it somewhat loamy. In 1919 the acreage was 1,907,046.

A large part of the potatoes if not immediately sold from the field are stored in dealer's warehouses or in cooperative warehouses until finally put on the market. Dealers usually charge 3c a bushel for storage, including insurance, between October 1 and January 1, and 1c a month or fraction per bushel for each succeeding month. Many farmers have storage cellars for potatoes, but do not always use them on account of the difficulty in handling the potatoes during extremely cold weather. The variety most extensively grown is the Rural New Yorker. Among other varieties grown are Cobbler, Triumph and Hebron. There is a gradually increasing number of potato growers who are co-operating with the State Experiment Station in the production of standard varieties. Many of these farmers are treating their seed according to instructions given by the College, are having their fields inspected by representatives of the Experiment Station, and are producing high grade, certified seed. The question of co-operating in storing and marketing the potato is also receiving considerable attention.

Rye was grown on 8,204 acres in 1909, and the total yield for that year amounted to 109,381 bushels. This crop is grown most extensively on sandy soils, and gives better results on the extremely sandy types than any of the other small grain crops. In 1919 there were 13,462 acres in rye and the average yield was 15 bu.

During 1909, barley was raised on 5,734 acres, and produced a total yield of 145,890 bushels. In 1919 there were 4,597 acres in barley. Its production is fairly well distributed over the county.

There was a gradual reduction in the growing of wheat from 1880 until 1910 when only 1,150 acres were devoted to this crop. Average yields during this year amount to about 20 bushels per acre. Owing to the great demand for wheat at the present time, there has been an increased acreage devoted to wheat production, though it is still very small as compared with the acreage of 30 years ago. In 1919 there were 1225 acres of winter wheat and 2315 acres of spring wheat in the county. The heavy types of Superior, Kennan, and Antigo series are well adapted to the growing of this crop.

The following table shows the acreage and production of the principal crops in the last four census years:

Crop	1879		1889		1899		1909	
	Acres	Bushels	Acres	Bushels	Acres	Bushels	Acres	Bushels
Hay	26,995	26,898T	37,867	44,368T	43,212	66,299T	58,286	98,771T
Oats	9.897	272,947	22,963	846,531	34,634	1,186,360	38,860	1,153,059
Corn	11,055	300,122	12,709	435,031	16,075	491,559	19.948	602.144
Patatoes	....	250,307	11.127	1,261,920	17,498	1,572,554	19,810	2,392,213
Rye	5,904	69,933	7,330	112,069	11.343	167,280	8,204	109.381
Barley	1,724	32,128	1,056	30,731	2.414	62,330	5,734	145,890
Wheat	21,731	252.925	12,564	212.889	12,160	240,400	1,150	21,955

It will be noted from the foregoing that the most recent statistical data quoted is from the U. S. Census taken in 1909. In order that the progress since that time may be studied there is given below more recent figures collected by the Cooperative Crop Reporting Service for Wisconsin.

The following table has been compiled by the Cooperative Crop Reporting Service For Wisconsin, and appears in Bulletin No. 28 of the State Department of Agriculture:

ANNUAL REPORT ON CROP AND LIVESTOCK PRODUCTION FOR WAUPACA COUNTY, WISCONSIN

	1919	1918	1909
No. of farms	3,613	....	3,417
Acreage in 22 cultivated crops including tame hay	158,700	156,593	139,078
Value 16 principal crops	$7,407,488	$6.077,189	....
Corn, all acreage	32.740	31,812	19,948
Production—bushels	1,440,560	1,145,232	....
Corn for grain, acreage	10,477	10,498	....
Production—bushels	481,942	388,426	....
Corn for silage, acreage	21,936	20,996	....
Production—tons	216,586	188,964	....
Silos, number	2,398	2,039	....
Oats—acreage	39,781	40,108	38,860
Production—bushels	1,074,087	1,604,320	....
Winter wheat, acreage	1,225	686	844
Production—busnels	20,825	14,406	....
Spring wheat, acreage	2,315	2,487	306
Production—bushels	23.150	54,714	....
Barley—acreage	4,497	5,066	5,734
Production—bushels	94,437	172,210	....
Buckwheat, acreage	481	620	373
Production—bushels	7,215	8,680	....
Rye, acreage	13,462	11,586	8,204
Production—bushels	201,930	208,548	....
Dry beans, acreage	97	249	115
Production—bushels	970	3,237	....
Dry peas, acreage	119	136	191
Production	1,547	1,768	....
Clover and timothy, acreage	47,777	44,549	44,017
Production—tons	71,643	44,549	....
Alfalfa, acreage	520	201	78
Production—tons	1,248	482	....
Other tame hay, acreage	357	482	387
Production—tons	536	578	....
Wild hay, acreage	8,360	9,085	9,566
Production—tons	9,196	10,902	....
Potatoes, acreage	17,991	18,145	....
Production—bushels	1,907,046	2,104,820	....
Cabbage, acreage	94	45	30
Production—tons	705	360	....
Sugar beets, acreage	88	187	102
Peas for canning, acreage	....	23	....
Other root crops, acreage	45	97	....
Flax, acreage	11	10	6

	January, 1920	January, 1919	April, 1910
Horses and mules, number	12,379	12,301	11,482
Milk cows, number	33,578	32,995	31,152
Other cattle, number	26,762	26.005	20,384
Sheep, number	5,656	5.160	7.246
Swine, number	27,045	28,658	23,672
Milk produced, cwt	1.665,462	....	....

Of the special crops cucumbers are grown to some extent mostly on the sandy soils. Salting stations are located at several of the towns within the county. In a few localities in the eastern part of the area sugar beets are grown. Most of these are shipped to the beet sugar factory at Menomonie. Cabbage is another crop of some importance, though it is not raised as extensively in this county as in Outagamie County to the east. Minor crops used in supplementary feeding are mangels, rape, peas, turnips and so forth. To supply the home needs there is grown the usual line of garden produce. Strawberries are raised to a limited extent, as are also raspberries, currants and other bush berries. The trucking industry, however, is not developed on a commercial scale in this region. Fruit growing receives but little attention in Waupaca County. Apples are grown more extensively than any other fruit, and most of the farms have a small home orchard, but apples are not raised on a commercial basis. The census of 1910 indicates that there are something over 60,000 apple trees in the county. Apples do best in those sections of the county where the surface is more or less rolling. The heavy level areas of soil, for example, are not well adapted to fruit, owing to the poor drainage conditions prevailing.

The raising of live stock is an important industry. In 1909 there were 51.536 cattle in the county, of which 31,152 were milch cows. During the same year the census reports indicate there were 23,672 hogs and 10,457 sheep. During that year there were 18,107 calves sold or slaughtered, and over 26,000 head of hogs were sold from the farms in the area. Hogs are raised chiefly in conjunction with dairying and general farming, though hog raising is not as well developed in this county as in sections where corn is more certain to mature.

Sheep are raised on a few farms and are confined most largely to the rougher portions of the area, though some are found in nearly all parts of the county.

The dairying industry is one of the most important in the county. The dairy products sold during 1909 amounted to $1,202,611, exclusive of home use. Of the dairy stock, cattle of Holstein breeding are most numerous with Guernseys second in importance. There are a few herds of Jerseys and also a few Short Horns. There are quite a number of pure bred herds of registered stock in the county, though the greater proportion of the herds are being built up from grade stock. There are several cow testing associations within the area, and as a result of the work being done along this line the cows of poor production are being gradually weeded out. The milk is manufactured into butter and cheese and a considerable amount is taken to the condenseries located at Manawa and New London. The total amount of milk is fairly evenly distributed through these three channels. Creameries are located in most of the princpal towns, and at some neighborhood centers. One of the most modern and up-to-date creameries is located at Iola. Cheese factories are most common in the southeastern and northwestern parts of the county. Most of the milk in the eastern and east-central part is disposed of to the condenseries. A large proportion of the cheese factories and creameries are run on the co-operative basis. On Jan. 1, 1920 there were 33,578 cows on the farms in Waupaca County. During 1919 the amount of milk produced was 1,665,462 cwt. and this has a value of $4,-879,804. In 1918 there were 53 cheese factories and 31 creameries in the county.

Farmers generally recognize the importance of the adaptation of crops to certain soils. It is generally recognized, for example, that rye will do better on the sandier type of soil than will any of the other small grain crops. It is generally considered also that potatoes can be grown more profitably upon soils of a sandy nature than on heavy types. In this region, where the season is somewhat short, corn is more certain to mature on the light sandy soils than on the heavy clay areas, because the sandy soils warm up more quickly in the spring. The sandy types, however, are not so well adapted to hay crops, and to oats and barley, as are the heavier soils. The general methods of farming followed are about the same as those practiced throughout the general farming and dairying districts of

Wisconsin. The silo is in quite common use on dairy farms and a considerable part of the corn crop is handled as ensilage. Usually sufficient means are taken to prepare the land for all crops. Plowing is usually to a depth of 6 or 8 inches, and on the heavier soils much of the plowing is done in the Fall. Disk harrows are frequently used for pulverizing the soil. On some of the sandier types rye is often sown without the land being plowed. In such cases the seed is harrowed or drilled in following the removal of the previous crop, and in the case of corn it is frequently sown before the shocks are removed. Where potatoes are grown, modern machinery is in common use, and where the acreage justifies their purchase most farms are supplied with horse-drawn planters, diggers and spraying outfits. In all lines of farming modern machinery is in common use on most of the farms.

Throughout most of the area the farms are equipped with substantial, well-built and attractive buildings. This is especially noticeable in the eastern half of the county. Practically every dairy farm has a silo. Many of these are made of wooden staves, but recently a large number have been constructed by the use of concrete. A number of the dairy farms are now equipped with power milking machines. Improved implements, such as manure spreaders, seeding and harvesting machinery, are in common use. Farm tractors are being introduced in a few places in an experimental way.

A rotation quite commonly followed on the sandy soils consists of small grain, followed by clover, and this by potatoes. The second crop of clover in some instances is plowed under as a green manuring crop, though this practice is not general. On the extremely sandy types it is desirable to arrange a system so that the ground may be covered as much of the time as possible to prevent drifting, which sometimes causes damage to growing crops. On the heavier soils the usual rotation is somewhat different from those on the sandy types. Here corn more frequently takes the place of potatoes, and the land is usually left in grass for hay for two years, and frequently is pastured for one year before again being plowed. On neither the sandy or heavy types has the question of crop rotation been given the careful consideration which it deserves.

Stable manure is the most common fertilizer used, a second crop of clover is frequently plowed under as a green manuring crop, and sometimes rye is plowed under. The practice of green

manuring, however, is not at all common. Commercial fertilizers are being used in a few cases, chiefly in an experimental way and mostly on the potato crop. It is certain that the use of commercial fertilizers will gradually increase since the results obtained on the potato crop in this and other counties are very gratifying. In the vicinity of Weyauwega on a sandy loam soil, unfertilized, the yield of potatoes was 85 bushels to the acre. On the same soil where 14 spreader loads of manure were used, supplemented with 500 pounds of a complete commercial fertilizer, the yield amounted to 350 bushels to the acre. Experiments which have thus far been conducted indicate that the best results with the commercial fertilizers are secured on soils which are in a fairly good state of fertility.

The question of securing competent farm labor is often somewhat difficult. In many cases, however, especially where the farms are small, the members of the family are able to do practically all of the farm work—extra labor being needed only at the time of haying and harvesting.

Farms usually range in size from 40 to 160 acres, although there are a number of holdings of 200 acres or more. On many of the larger farms there is a considerable amount of unimproved land. The average size of all farms in the county, according to the 1910 census, was 110 acres. In 1910 there were 3,794 farms in the county and in 1920 there were 3,770 farms.

The last census reports that 90.1% of all farms in the county were operated by the owner. Most of the rented land is in the poorer sandy sections. Rent is usually on the share basis, the tenant furnishing equipment and half of the stock and seed and receiving one-half of the farm produce. While the share system is most common, there are a number of variations in this system.

The value of lands has been steadily increasing in this county. The better improved farms sell from $100 to $150 per acre where well located. Cut-over lands, mostly in the northwestern part of the county, have a selling value from $15 to $35 per acre. The farms in the sandy region where the fertility of the soil is sometimes low and the improvements rather inferior have a value of around $40 per acre, though this of course is extremely variable depending upon a number of factors.

CLIMATE

The climatic conditions in Waupaca County are fairy representative of a considerable area in the central part of Wisconsin. While the topographic features of the county are not uniform for all sections, there is probably not a great variation in liability to frost in various parts of the county except over the marsh areas. As none of the large marshy tracts have been reclaimed, the question of liability of frosts on these marshes at times when the frost would not affect the upland is not of great importance at the present time. As the marsh areas are reclaimed here, it will doubtless be found to be true in this region, as in other sections of the state, that frost in the marsh land will occur about the same time as frost in the upland will occur at a point one hundred miles farther north.

The table given below contains climatic data gathered by the Weather Bureau Station located at Waupaca. This station has an elevation of about 870 feet above sea level.

The following table shows the normal monthly and annual temperature and precipitation at Waupaca:

NORMAL MONTHLY AND ANNUAL TEMPERATURE AND PRECIPITATION

	Mean temperature	Highest temperature	Lowest temperature	Mean precipitation
January	16.2	51	—32	1.01
February	15.5	53	—38	0,93
March	29.0	72	—16	2.08
April	44.1	86	7	2.66
May	56.4	91	20	4.14
June	65.3	102	30	4.42
July	70.7	100	42	3.48
August	68.1	96	36	3.41
September	60.9	95	18	3.25
October	48.2	85	11	2.29
November	33.6	68	—13	1.71
December	19.5	50	—24	1.28
Annual	44.0°	102	—38	30.66

From the above table it will be noted that the average rainfall for the year amounts to nearly 31 inches. A large proportion of this occurs during the growing months when most needed, but occasionally, especially in July and August, crops may suffer somewhat from the lack of moisture. Storms of a destructive nature are very rare. The climate of the region is healthful and well suited to a high development of agriculture. While the winters are long and rather severe, the temperatures are much more uniform than farther south. The average snowfall amounts to about 40 inches. The summers are very pleasant and farm crops make rapid growth.

The average date of the last killing frost in the spring, as recorded at Waupaca, is May 22, and the average date of the first killing frost in the fall is September 28. This gives an average growing season of 137 days free from killing frosts. The average season is therefore sufficiently long to permit the maturing of corn. However, early fall frosts frequently occur which damage the crop, as was the case in 1917, when but little corn matured in Wisconsin. Corn will always mature sufficiently, however, for silage, and a large proportion of the crop is disposed of in this way.

Excellent water for household purposes and for stock can be readily secured in all parts of the county. There are many flowing wells in the eastern half of the county. In the southwestern part of the area there are a number of lakes known as the Waupaca chain of lakes which attract many tourists during the summer season.

SUMMARY

Portage County is situated a little to the east of the center of the state. It comprises an area of 759 square miles or 485,760 acres. The surface features vary from level to rolling to hilly, with the major part of the county gently rolling. Elevations along railroads range from 767 to 930 feet aobve sea level. All of the county lies within the drainage basin of the Wolf River. The Embarrass, Waupaca, and Little Wolf are tributaries of the Wolf River which traverse portions of the area surveyed.

The first settler came to Waupaca County in 1843, and settled at the present site of Fremont. The county was organized in 1851. In 1910 the population of the county was 32,782 of which 83.7% was classed as rural. This is a well established region, and population is fairly well distributed throughout the county. The largest tracts of unimproved land are in the northwestern part of the county.

This country is traversed by the main line of the Green Bay & Western Railroad, the Soo Line, and the eastern side of the area is skirted by the Chicago & Northwestern Railway.

The mean annual rainfall is approximately 31 inches, and the mean annual temperature 43.9 degrees. The winters are long severe with a snow fall of about 40 inches, but the summers are warm and all crops make rapid growth. There is an average growing season of 127 free from killing frosts.

The agriculture of the county shows all stages of development. The southwestern portion of the area has considerable sandy soil some of which has a low value for farming purposes. There are also some sandy spots in other parts of the county but not of such great extent. There are many highly improved farms within the area, and this is one of the leading potato growing districts of the state.

The principal crops grown are hay, oats, potatoes, corn, rye, barley, some wheat and buckwheat. General farming is the prevailing type of agriculture, with dairying and potato growing as the most important interests. The average size of farms is 110 acres and approximately 90% of the farms are operated by their owner.

The soils of this county are variable and range in texture from sand to clay. There are numerous areas of marshland but little of which has been reclaimed to date. The material forming the soils has been derived largely through glacial action from crystalline and sandstone rocks. The underlying rock in the western half of the county is largely crystalline, while the eastern half is chiefly sandstone. There is also considerable lacustrine material in the county, but since its deposition by water it has been influenced by glacial action. In the low, undrained places there are large accumulations of organic matter making up the peat marshes.

In the classification of the soils of this county these various materials have been separated into 10 soil series and 24 types, not including peat. In several instances phases of types have also been recognized. Each soil has peculiar characteristics by which it can be recognized, and the full understanding of these characteristics are necessary in the selection of crops and systems of farming best suited to each soil.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

W. O. Hotchkiss, Director and State Geologist.
A. R. Whitson, in Charge, Division of Soils.

SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. Russell, Dean.

BULLETIN NO. 54D **SOIL SERIES NO. 26**

SOIL SURVEY

OF

OUTAGAMIE COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, MARTIN O. TOSTERUD, MARION C. FORD AND E. J. GRAUL

OF THE

Wisconsin Geological and Natural History Survey

AND

HORACE V. GEIB

OF THE

United States Department of Agriculture

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS, MILTON WHITNEY, CHIEF
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*Scientist in Soil Survey, in charge of field operation in Wisconsin for U. S. Department of Agriculture, Bureau of Soils.

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INTRODUCTION

Before the greatest success in agriculture can be reached it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering

suggestions for their management, based upon the work of the Soil Survey within the area covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water-holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture as long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere.

Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis,* which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater

proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.

Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.

Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.

Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Sandy clay.—Less than 20% silt.

Soils Containing over 50% of Silt and Clay

Loam.—Less than 20% clay, and less than 50% silt.

Silt loam.—Less than 20% clay, and over 50% silt.

Clay loam.—Between 20 and 30% clay, and over 50% silt.

Silty clay loam.—Between 20 and 30% clay, and over 50% silt.

Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a gradation in texture of otherwise uniform material, such a group is called a *soil series.* It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. As the soils of this series have been

derived largely from sandstone, the types are mostly of a sandy nature. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey. By uniting the soil class with the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF OUTAGAMIE COUNTY, WISCONSIN

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA.

Outagamie County is located in the east-central part of Wisconsin, and covers an area of 646 square miles, or 413,440 acres.

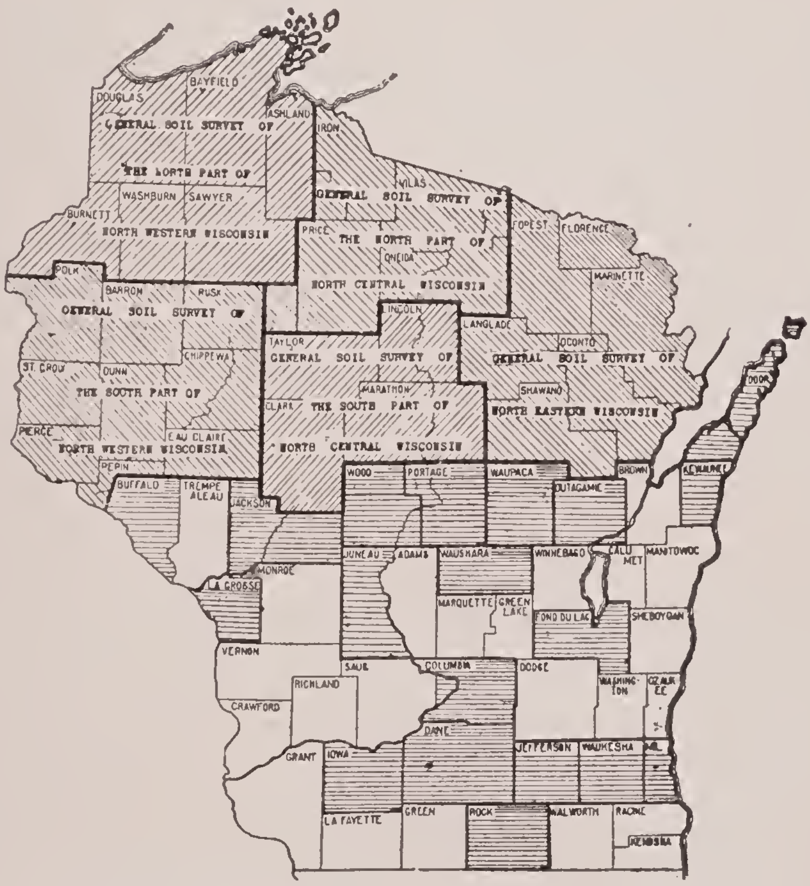

Figure 1.—Sketch map showing progress of the soil survey.

Viewed from an agricultural standpoint, Outagamie County ranks with the foremost of the state. Over 80 per cent of the total area is in farms, and more than two-thirds of this is improved land. Several rather large areas of marsh occur in the north-western part of the county. Lying between the Embarrass, Wolf and Shioc Rivers is a broad, flat stretch of fairly fertile soil, which was principally laid down by these streams during seasons of high water. This area covers most of the townships of Deer Creek, Maple Creek, Liberty and the west part of Cicero.

In the townships of Liberty and Hortonia, and between Hortonville and Stephensville, numerous hills and ridges of fine sand occur. Similar hills are also found in the northern part of the town of Maine.

South and east of the low flat plains mentioned above is the most important farming section of the county. It consists of the rolling, fertile Superior soils. The highly improved condition of the farms, the excellent farm buildings and the modern school houses and churches all point to these soils as being among the most productive of the region. The remainder of the county to the southeast is principally occupied by the level, heavy, Superior soils. In fertility and productiveness, they rank close to the rolling Superior, but on account of their low flat character they are usually deficient in drainage.

The northern and western portions of Outagamie County are drained through the Wolf River and its tributaries into Lake Michigan.

The Wolf, the Embarrass and the Shioc Rivers draining the north-western part of the area are all slow, meandering, sluggish streams within this area, and a great deal of the low, flat surrounding territory is subject to overflow in the spring of the year. The streams in the eastern and southern parts of the county have a larger amount of fall. The Fox River in a distance of thirty-five miles, has a difference in elevation of 170 feet. The excellent water power facilities offered by this stream have been highly developed and have made this region famous as a paper and pulp producing center.

The first white man to settle in the county was probably Dominique Ducharme, who established himself in 1790 near the present site of Kaukauna. In 1851, Outagamie County was formed from Brown County.

Over Outagamie County the population is quite evenly distributed. The township of Maine is most thinly settled, and the region directly bordering the Fox River is the most thickly settled. The census of 1920 reports the population of the county as 55,113. This gives an average of 85.3 persons per square mile.

Outagamie County is well supplied with railroad facilities. The wagon roads through the county are generally in fair condition. A system of concrete roads is now under construction, which when completed will connect all of the principal towns in the county.

The towns within the area afford a market for much of the farm produce, but the greater part is shipped to outside points. Of the agricultural output, dairy products are most important. Butter and cheese are shipped to all parts of the country. Several milk condenseries are located within the county. Livestock of all kinds are shipped from towns in the area. Excellent markets are within easy access of all farms.

ONEIDA INDIAN RESERVATION.

The Oneida Indian Reservation is located in the north-east corner of Outagamie County. The entire reservation consists of over 60,000 acres of land, but nearly half of this is in Brown County.

In 1824 about eighty Oneida Indians coming from the state of New York purchased land of the Menominee Indians along Duck Creek within the present boundaries of the reservation. More of the same nation continued to come, and by 1838 the colony numbered about 650. In this year the United States Government made its first treaty with them, setting aside one hundred acres of land for each individual. The Indians, as a rule, have done little to improve the land within the reservation, although a few have cleared farms and built homes.

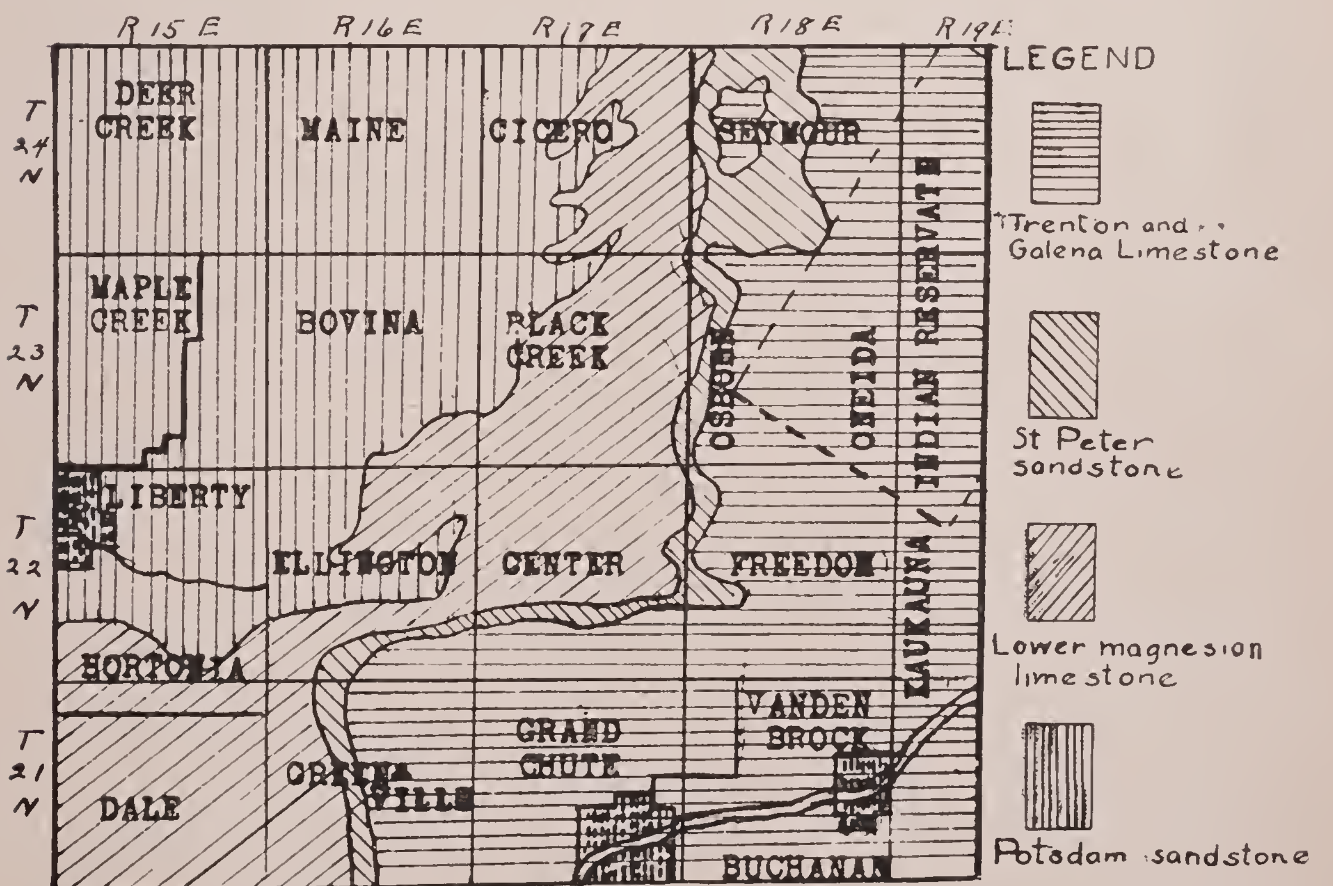

Figure 2.—Sketch map of Outagamie County, showing the underlying rock formations, from which the soil has in part been derived.

During the past few years most of the Indians have been given a clear title to their lands, with the privilege to sell or dispose of the same, and, due to this fact, white settlers and land companies are rapidly getting control of a larger part of the area, and are clearing and improving much of the excellent land which has heretofore lain idle.

Near Oneida Station, within the reservation, the Government maintains a free school with a farm where the Indian children may be sent for nine months of the year with no expense whatever to the parents. District schools are also maintained throughout the area, and several churches have been erected. The bulk of the population is in the southern part of the reservation, the thickest settlements being along the banks of Duck Creek. The northern part is very thinly settled.

SOILS.*

Outagamie County, in common with the greater part of eastern and northern Wisconsin, owes the general character of its surface material to several distinct methods of accumulation. These materials may be of glacial, alluvial or lacustrine (deposited in lakes) origin. In addition to these agencies may be added the accumulation of organic matter in low places which has resulted in the formation of large areas of peat soils. In a

*In comparing this issue of the soil survey report of Outagamie County with the edition published by the United States Bureau of Soils it will be noted there is some difference in the naming of some of the soil types. In the State report the types have been correlated with the soils as previously mapped within the State while in the report issued by the United States Bureau of Soils the types have been correlated with the soils as they occur in adjoining States. The following table gives the various soils to which different names have been applied in the two reports.

Soil Type Names as used by U. S. Bureau of Soils	Soil Type Names as used in the report issued by the State of Wisconsin.
Clyde fine sandy loam—till phase	Clyde fine sandy loam
Clyde silt loam—till phase	Clyde silt loam
Coloma very fine sand	Coloma fine sand
Genesee very fine sandy loam	Genesee fine sandy loam
Kewaunee fine sandy loam	Superior fine sandy loam—rolling phase
Kewaunee loam	Superior loam, rolling phase
Kewaunee silt loam	Superior silt loam, rolling phase
Kewaunee clay loam	Superior clay loam, rolling phase
Merrimac very fine sandy loam	Antigo fine sandy loam
Merrimac loam	Antigo loam
Plainfield very fine sand	Plainfield fine sand

geological classification which takes into consideration the underlying rock formations the county naturally falls into several divisions.

The bed rock underlying the soils of Outagamie County consists of two radically different formations, sandstone and limestone. There are two ages of sandstone and two ages of limestone. The accompanying sketch map shows the approximate location and extent of the four rock formations which make up the surface rock of this region. These are the Potsdam sandstone, lower magnesian limestone, St. Peter's sandstone and Trenton and Galena limestone.

All of these formations have contributed to some extent to the soils of the region. In addition the glacier carried quantities of the granitic material over onto the other rock formations. The granitic boulders frequently seen are an evidence of this action.

Another formation within the county is represented by the heavy red clay. This red material was deposited in quiet waters when the Great Lakes stood at a much higher level than at present. After being deposited, this material was acted upon by the ice sheet and was mixed to some extent with other materials. The surface in places was left level, as along the Fox River, and rolling as in the Town of Dale and elsewhere.

As a result of the various geological agencies which have influenced this region, the surface of the county falls into three rather distinct divisions.

The northwestern quarter of the county consists of an extensive alluvial plain in which the soils have been deposited by flood waters from the Wolf, Shioc and Embarrass Rivers. These streams traverse regions of both sandstone and crystalline rocks and the alluvial soils are therefore a mixture of materials from both these sources. Within this region there are extensive marsh areas, consisting for the most part of peat.

In the southeastern part of the county there is a considerable area along the Fox River where the soil is a heavy red clay, and where the surface is level, it having been influenced to only a limited extent by glacial action since its deposition.

Between this region and the one described as covering the northwestern quarter of the county, there is another region much larger than either of the other two, in which is found

the best agricultural land within the area. It is a rolling country in which the subsoils are largely made up of red clay which has been mixed by glacial action with glacial material from both sandstone and limestone formations.

In the survey of Outagamie County, these various materials have been classified into ten soil series and nineteen soil types. The soil series (which correspond to the family group) are described here only very briefly. The individual soil types are fully described and are shown on the map, each being indicated by a distinct color. It is the soil types in which we are especially interested since the type is the unit in mapping and classifying soils. Following is a complete list of the soil types mapped in the county, and the series or family group to which each type belongs.

The Superior series is characterized by the heavy red clay which forms the subsoil of all the types within this series. Typically the surface is level or nearly so, and the natural surface drainage is somewhat deficient. Where this same material occurs and the surface is sufficiently rolling to insure fair to good surface drainage, the term *rolling phase* is used to describe it. In this county the rolling phase of the various types is more extensive than the typical soil. The types mapped are the Superior clay loam, silt loam, loam, and fine sandy loam. With each of these types a rolling phase was also mapped.

The Poygan series includes dark colored, low-lying, poorly drained soils underlain by heavy red clays. The types mapped in this area are Poygan clay loam, silt loam, and fine sandy loam.

The Coloma series includes light-colored upland soils which have been derived chiefly from glaciated sandstone. The types mapped are Coloma fine sandy loam and fine sand.

The Antigo series includes light-colored soils which occur as level tracts known as outwash plains or stream terraces. These soils have been derived chiefly from glaciated granitic material and to a lesser extent from sandstone material, all of which has been re-deposited by running waters. The types mapped here are Antigo loam and fine sandy loam.

The plainfield series is similar to the Antigo except that the material forming it has been derived largely from sandstone instead of from granite rocks. The Plainfield fine sand is the only type of the series mapped in this county.

The Miami series consists of light-colored upland soils which were originally timbered and which consist of glacial material derived in part from limestone. The types mapped in this county are the Miami loam and fine sandy loam.

The Whitman series consists of low-lying, poorly drained, dark-colored soils which occur within stream valleys as plains or depressions in the upland where the material has come largely from glaciated granitic regions and where the soils are in an acid condition. The types mapped are the Whitman loam and the Whitman fine sandy loam.

The Clyde series consists of low-lying, poorly drained, dark-colored soils occupying stream valleys, old lake beds or ponded valleys where the soil material has come largely from limestone. It is very similar to the Whitman series except that it contains a considerable amount of lime carbonate and is very seldom in an acid condition. The types mapped were Clyde silt loam and fine sandy loam.

The Dunning series includes dark-colored, light-textured, poorly drained soils, where the parent material for the most part is sandstone. The soils of this series are acid. The types mapped are Dunning loam and fine sandy loam.

The Genesee series consists of brown or light brown soils which occur as first bottom land. In this area they are of very limited extent and of minor importance. Two types, silt loam and fine sandy loam, were mapped.

In addition to these various soils, there are extensive areas mapped as peat. This consists of decaying organic matter, with which there has been incorporated a very small amount of fine earth.

In the subsequent pages of this report, the various soil types mapped in Outagamie County are discussed in detail.

The distribution of the various soils is shown on the map, and the actual and relative extent of each is shown in the following table.

AREA OF DIFFERENT SOILS.

Soil	Acres	Per Cent
Superior loam	23,488	
Superior loam rolling phase	62,656	20.9
Peat	51,264	
Shallow phase	8,704	14.5
Superior fine sandy loam	7,808	
Superior fine sandy loam rolling phase	49,984	14.0
Superior clay loam	28,032	
Superior clay loam rolling phase	22,528	12.3
Superior silt loam	22,528	
Superior silt loam rolling phase	26,368	11.8
Poygan silt loam	17,216	4.2
Antigo fine sandy loam	16,512	4.0
Coloma fine sand	15,488	3.7
Antigo loam	12,928	3.1
Genesee silt loam	12,672	3.1
Whitman fine sandy loam	9,792	2.4
Whitman loam	5,888	1.4
Miami fine sandy loam	5,184	1.3
Poygan clay loam	4,352	1.0
Plainfield fine sand	2,560	.6
Genesee fine sandy loam	2,176	.5
Clyde silt loam	1,728	.4
Coloma fine sandy loam	1,152	.3
Poygan fine sandy loam	960	.2
Clyde fine sandy loam	832	.2
Miami loam	576	.1
	413,440	

CHAPTER II.

GROUP OF HEAVY SOILS.

SUPERIOR SILT LOAM.

Extent and distribution.—This soil occupies a total area of about one township. Irregular tracts ranging in size from a few acres to five or six square miles extend across the eastern part of the county in a northeasternly and southwesternly direction. It occurs more extensively in T 24 N, R 19 E in the towns of Osborn, Freedom, Grand Chute, and Center. There are only a very few small patches in the west half of the county.

Description.—The surface soil of this type to a depth of about eight inches consists of a brown silt loam containing a considerable amount of organic matter. The surface soil is free from gravel and stones. The subsoil consists of a heavy compact pinkish red clay, which extends to a depth of over three feet.

There are some variations in this soil, the chief one being the depth of the silty material over the heavy red clay subsoil. This may vary from four to five inches up to ten or twelve inches. There is also some variation in the amount of organic matter, the largest amount being found in areas which are slightly depressed. Aside from these variations, which are all of minor importance, the type is very uniform.

Topography and drainage.—The surface of the Superior silt loam is level, or only very gently undulating, and because of the heavy character of the subsoil, natural drainage is somewhat deficient. During spring, when heavy rains are common, the soil becomes saturated, hence it warms up more slowly than soils having a more rolling surface. Over a considerable part of this type tile drains could be installed to good advantage.

Origin.—The material forming this soil has been derived largely from lacustrine (lake laid) material which was deposited in quiet waters at a time when the Great Lakes stood

at a much higher level than at the present time. After this first deposition it was modified to some extent by glacial action.

Native vegetation.—The original timber growth consisted chiefly of maple, birch, elm, some beech, and pine. Practically all of the merchantable timber has been removed. Most of this soil has been cleared, and is now in highly improved farms. About the only exception to this is in the extreme northeast corner of the county in T 24 N, R 19 E where the land was until very recently a part of the Indian Reservation.

*Present agricultural development.**—The chief crops grown consist of hay, small grains, corn, and root crops. It is naturally a strong productive soil; when drainage is provided, very good yields are secured. On practically all of the farms made up of this soil, there is some land which is too wet for the growing of cultivated crops without supplying some form of drainage. When thoroughly drained, this soil will rank along with the best in the county. It is somewhat more difficult to cultivate than soils of lighter texture, but if plowed when moisture conditions are favorable, a good seed bed can be secured with but little difficulty.

SUPERIOR SILT LOAM.

ROLLING PHASE.

Extent and distribution.—This soil covers a total area of approximately one township, and is the predominating type in the town of Greenville. It is also quite extensive in the town of Grand Chute, and there are numerous small tracts in the southeast part of the county.

Description.—The surface soil to a depth of about eight inches consists of a brown to dark brown rather compact silt loam containing a moderate amount of organic matter. It is practically free from gravel and stones are seldom found upon it. The subsoil into which the surface material grades quite abruptly consists of the heavy red clay which is characteristic of this series.

Topography and drainage.—The surface of this soil varies from undulating to gently rolling, and in some instances it could be classed as rolling. On account of the surface features the

*For chemical composition and improvement of this soil, see page 23.

VIEW SHOWING TYPICAL LEVEL TO GENTLY UNDULATING SURFACE FEATURES OF THE SUPERIOR SOILS.

Where the soils of this series are heavy the natural drainage is somewhat Deficient.

VIEW OF SUPERIOR CLAY LOAM, ROLLING PHASE.

The term "rolling phase" is used where the surface is sufficiently rolling to insure fair to good natural drainage.

natural surface drainage is usually good, although the heavy compact subsoil does not permit the water to move freely through it. On some of the more gently sloping portions of the type, and in depressions between hills lines of tile could be installed to good advantage.

Origin.—This soil has been derived largely from lacustrine material which has been influenced to a considerable extent since its first deposition by the action of ice.

While the surface soil is sometimes found to be slightly acid, the subsoil usually contains a considerable amount of lime carbonate.

Native vegetation.—The original forest growth consisted chiefly of maple, birch, basswood, hickory, with some beech, elm, hemlock, and pine.

*Present agricultural development**—This is one of the desirable soils of the county, and one upon which agriculture is very highly developed. It is a strong productive soil, and well adapted to the general farm crops common to this region. Small grains and grasses do especially well, and the dairy industry is the most important line of farming followed.

The rotation most commonly followed consists of small grain, followed by clover, or clover and timothy, followed by corn.

This soil is not so difficult to cultivate as is the clay loam, but nevertheless, it requires heavy working stock and tools.

SUPERIOR CLAY LOAM.

Extent and distribution.—Superior clay loam is found chiefly in the towns of Kaukauna, the southeastern part of Freedom, Vandenbroek, and Grand Chute. The total area is approximately one township.

Description.—The surface of the clay loam to an average depth of six inches consists of a light grayish-brown clay loam which grades quite abruptly into the heavy compact red clay which extends to an undetermined depth. The light-colored material over the red clay varies somewhat in depth from one or two inches to seven or eight inches. In the heavy clay subsoil, especially, in the lower depth, it is not uncommon to find thin seams of fine and very fine sand. It is also common to find in the soil section a small amount of very fine rock fragments largely of limestone.

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*For chemical composition and improvement of this soil, see page 23.

The texture of both the soil and subsoil of this type is very uniform.

Topography and drainage.—The surface of this soil is level or only very gently undulating, and the natural drainage is deficient. During the early spring, portions of the type are frequently covered with an inch or so of water. Because of the heavy subsoil and the slowness with which water moves through it, the type remains wet and cold for some time during the early part of each growing season, and the planting of crops is frequently delayed on this account. Practically all of this soil could be improved by tile drainage although up to the present time but very few have been installed.

Present agricultural development—Practically all of the crops common to the region are grown with success upon this soil, but it is better adapted to small grains and grasses than to corn. Where drainage has been supplied, corn can be grown successfully, and all the other crops are much more certain of giving satisfactory yields. Tile drainage permits the soil to warm up much earlier in the spring which gives the crops a better start.

SUPERIOR CLAY LOAM, ROLLING PHASE.

Extent and distribution.—This soil is chiefly found in the southeast portion of the county, and is the predominating type in the towns of Vandenbroek and Buchanan. Small patches are found in the towns of Grand Chute, Greenville, Center, and Black Creek.

Description.—The surface of this soil to a depth of three to four inches is a compact silt loam, or silty clay loam, of a brown or slightly reddish-brown color. This material grades abruptly into a heavy compact pinkish red clay subsoil. This heavy material extends to a great depth and some of the road cuts and stream channels show it to extend to a depth of forty to fifty feet. The surface of the type is practically free from stones and only a very small amount of gravel is ever found upon it. In the soil section, a very few small limestone fragments or concretions are sometimes found.

Topography and drainage.—The surface varies from undulating to rolling. In a few instances in Buchanan township the

*For chemical composition and improvement of this soil, see page 22.

surface is quite broken. Because of the uneven character of most of this soil the surface drainage is good. The compact subsoil, however, does not permit the water to move freely within the soil. The only difference between this soil and the typical Superior clay loam is the difference in topography.

*Present agricultural development.**—Practically all of the merchantable timber has been removed, and very nearly all of the type is now cultivated. This is an excellent soil, well adapted to general farming and dairying, and all of the farm crops common to the region are successfully grown upon it. A rotation quite commonly practiced consists of small grain one or two years, followed by clover or a mixture of clover and timothy for one or two years, and then followed by corn.

About the only fertilizer used is stable manure, but since the soil is very heavy and somewhat deficient in organic matter, a practice which is good, but not common, is to supplement the stable manure by plowing under a green manuring crop about once in four or five years, and for this purpose legumes are best.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SUPERIOR SILT LOAM AND SUPERIOR CLAY LOAM.

These soils are similar in the texture and structure of the subsoil section. They differ chiefly in topography and texture of the surface soil, as indicated by the type names. The types are so closely related that methods for the improvement of one will apply to the others.

The four elements with which the farmer is most concerned in his farming operations, and the ones which are the most apt to be deficient, are nitrogen, phosphorus, potassium and lime or calcium. He should know the part which each plays in the development of the plant, and what are the best methods of maintaining an adequate supply in the soil.

The soil has been leaching for a large number of years, and has lost some of the lime carbonate which it contained. Varying degrees of acidity have developed over the region. The loss of lime (calcium carbonate) from the soil is caused by two distinct factors, both of which are important. Crops require lime in their growth. A five-ton crop of alfalfa requires 185

pounds of lime and two tons of red clover requires 61.6 pounds. A much larger amount is removed by leaching each year and these losses must be made up by the application of lime in order to maintain the fertility of this soil.

Tests show that the subsoil is usually well supplied with lime and that the deficiency is confined largely to the surface soils.

While it will be seen from tests that part of this land shows some degrees of acidity it does not mean that all of this land is in immediate need of lime. Where such crops as alfalfa, sugar beets, tobacco, peas, cabbage and other garden crops are grown and where the acidity is medium two tons per acre of ground limestone may be used with profit. Where a liberal supply of manure is available the need for lime will not be so great.

Where such crops as corn, clover and oats are grown with manure applied once during each rotation a smaller amount of lime will be needed. On parts of the farm where manure cannot be applied the lime can be used with profit on such soils and may be actually necessary for economic production. The greater need will usually be on the higher places, rather than on the lower slopes.

It has been quite definitely established that the need for lime in acid soils runs practically parallel with the need of phosphorus. The use of lime alone will not make enough phosphorus available, and the use of a phosphate fertilizer will not supply the lime requirements of the soil. Either lime alone or acid phosphate alone will give increased yields, but neither alone will give as great an increase nor as profitable an increase as when both are supplied. In the improvement of acid soils, therefore, provisions for the use of both lime and a phosphate fertilizer should be made.

Phosphorus exists in all soils in Wisconsin in small amounts. Many of the best types in the state contain only 1,200 pounds to the acre eight inches deep, and this is in a form which becomes available to crops very slowly. Phosphorus is constantly being lost from the farm in crops, milk and in the bones of animals sold. It is well understood that when grain, hay, potatoes or other cash crops are sold, this element is removed from the farm. This element cannot be supplied from the air and in

the long run the loss must be made up through additions of phosphorus fertilizer in some form.

The chemical analyses of the Superior silt loam and clay loam soils show that their phosphorus content is somewhat lower than the average of other silt loams and clay loams in the State, while the potassium content is larger. Their content of organic matter is somewhat below the average of soils of this texture. In regard to lime they vary within very wide limits, in some sections the soil being acid, while in others they contain as high as ten to twelve per cent of lime carbonate. It should be borne in mind that where soils are acid the amount of phosphorus which they do contain is not so readily available to plants as in soils which are not acid.

On good uplaid soil where dairying or general farming is practiced the use of 300 pounds of 16% acid phosphate or 100 pounds of 44% superphosphate to the acre every four years will maintain the phosphorus supply. If much grain, potatoes or other crops are sold, about double these amounts should be used.

On soils relatively low in fertility somewhat more phosphate should be used at first. This is especially true of the soils which have grown corn or small grain a long time without the use of manure or other fertilizer.

If considerable amounts of bran or cottonseed meal are fed, which are relatively high in phosphorus, the supply of this element may be maintained. It would usually be necessary to feed at least one-half ton of bran or cottonseed meal to each cow on a dairy farm per year to maintain the phosphorus supply of the soil. Since comparatively few farmers follow this practice, some phosphate fertilizer should be used.

Potassium exists in these soils in large amounts. They often contain over 50,000 pounds of this element per acre to a depth of eight inches, while they contain only 1-20 as much phosphorus. This potassium, however, in the form in which it exists in the soil is not readily available to crops and becomes so only as a result of chemical changes which are chiefly brought about through the action of organic matter. When a good supply of active organic matter is maintained the quantity of potassium is sufficient to supply growing crops almost indefinitely and it is only in the case of fields low in organic matter or where

crops using unusually large amounts of available potassium are grown that fertilizers containing this element need be used.

Nitrogen is chiefly responsible for the dark green, healthy color and rapid growth of corn or other crops on well manured land. It is important to have sufficient amounts in the soil, but when in excess it is detrimental to some crops. The quality of the grain may be injured by too much nitrogen. When the grain lodges the kernels do not fully mature.

Virgin soils contain large amounts of nitrogen but if they are cropped continuously to such crops as corn, oats and timothy without the addition of fertilizer material containing nitrogen the nitrogen supply is gradually exhausted and the yields are reduced.

Nitrogen exists in the soil almost entirely in combination with organic or vegetable matter. In the light colored soils the vegetable matter is relatively low and should be increased. The accumulation of organic matter high in nitrogen is most readily brought about through the growth of legumes such as clover, alfalfa or soy beans. These may either be turned under as green manuring crops in which case all of the nitrogen collected from the atmosphere is returned to the soil and made available to succeeding crops, or they may be fed to animals and the manure returned to the soil so that a portion at least of the nitrogen gathered from the atmosphere is returned to the land to add to the supply already there. Whatever system of farming is followed on these soils should include a rotation one member of which is a legume.

Certain crops such as potatoes and vegetables are frequently grown by farmers who do not keep much livestock and who do not rotate these crops with legumes. In such cases fertilizers containing nitrogen and potash, as well as phosphorus may be used. Mixed fertilizers are, therefore, manufactured and offered for sale. The composition of these fertilizers is indicated by a formula. A 2-10-4 fertilizer, for instance, is one containing 2% of ammonia, or nearly 2% of nitrogen, 10% of phosphoric acid and 4% of potash.

When nitrogen and potash are needed as well as phosphoric acid, there is some advantage in using these mixed fertilizers. But when the farmer needs to use only a phosphate fertilizer, purchasing a mixed fertilizer means that he is buying not only

nitrogen and potash which he does not need, but he is compelled to pay a considerably higher price for the phosphate he gets than is the case when he buys a fertilizer containing phosphate only. Experiments on this soil at Ashland showed a large increase through the use of phosphate fertilizer, in addition to manure. The following table gives the results of some of these experiments.

Crop	Ten tons manure only	Ten tons manure and 1,000 lbs. rock phosphate	Percent of increase
Potatoes	87 bu. per A.	128 bu.	47
Rutabagas	108 bu. per A.	137 bu.	27
Corn	30.4 bu. per A.	36.8 bu.	21
Clover hay	2,223 pounds	3,177 pounds	43
Clover seed	217.5 pounds	336.7 pounds	47

The importance of having sufficient supplies of this element is made still greater by the relatively poor drainage which the Superior clay loam has and its consequent tendency to be cold so that crops are slow in maturing. The element phosphorus is particularly helpful in hastening the maturity of crops and the formation of seed.

Phosphorus may also be supplied as acid phosphate in which form it is immediately available to plants. In the form of rock phosphate the phosphorus becomes available slowly.

Where the surface of the heavy soil is level, as is frequently the case, the question of drainage is one of importance. Over practically all such level areas tile drains could be installed to advantage. Thorough drainage will make these soils warm up earlier in the spring, insure better tilth and increase yields.

CHAPTER III.

GROUP OF LOAMS AND FINE SANDY LOAMS.

SUPERIOR LOAM.

Extent and distribution.—The Superior loam occupies a total area of approximately one township. It is found most extensively in the northern half of T 24 N, R 19 E in the towns of Seymour, Osborn, Freedom.

Description.—The surface soil of this type to a depth of about ten inches consists of a dark brown friable loam which contains a moderate amount of organic matter. This type is also free from stones and contains but very little gravel. The subsoil below ten inches grades abruptly into the heavy compact red clay which is characteristic of this series. This bed of clay extends to an undetermined depth, probably forty to fifty feet at least.

Topography and drainage.—The surface of this type, as is characteristic of this series, is level or only very gently undulating, and because of the level surface and heavy subsoil the natural drainage is somewhat deficient. These are associated with this soil a large number of areas of soils belonging to the Poygan series which occupy poorly drained depressions.

A large part of the Superior loam would be benefited by tile drainage, although up to the present time, but few tile drains have been installed.

*Present agricultural development**—Most of this soil has been cleared and placed under cultivation, and is now in highly improved farms. About the only exception to this of any note is in the northern part of T 24 N, R 19 E where a portion of this soil was included in the Indian Reservation. Practically all of the general farm crops common to this region are grown upon this type. It is a good general farming soil, especially adapted to small grains and grasses. The dairy industry has been developed to a considerable extent upon it.

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*For chemical composition and improvement of this soil, see page 36.

SUPERIOR LOAM, ROLLING PHASE.

Extent and distribution.—This is one of the most important and extensive types of soil in Outagamie County. It is confined chiefly to the eastern half of the county, and is the predominating type in the towns of Seymour, Osborn, Freedom, and Center. Small tracts of this soil are found in every town of the county with the exception of Maine and Deer Creek.

Description.—The surface soil to an average depth of about ten inches consists of a brown mellow loam. It contains only a moderate amount of organic matter. The subsoil which extends to an undetermined depth consists of the heavy compact red clay which is so common in this region. There are very few stones on this soil—in fact, it may be said to be stone-free, and it is very seldom that gravel is found either on the soil or in the soil section. In a few instances, small knolls are found upon the surface of which there is a small amount of gravel.

Topography and drainage.—The surface of this soil ranges from undulating to gently rolling and the natural surface drainage is, for the most part, good. Where the phase borders typical Superior soils and the slope is only moderate, the drainage is sometimes slightly deficient. This is also true of some depressions and some of the land along streams. In such places, a line of tile could frequently be installed to good advantage.

*Present agricultural development**—This is one of the most important and highly improved soils of Outagamie County, and many of the finest farms in the region are located upon it. Almost every acre is tillable. All of the farm crops common to the region are successfully grown, and the yields are somewhat higher than on the clay loam soils. This is partly due to the fact that the soil can be worked under a somewhat wider range of moisture conditions, and can be placed in better tilth at a somewhat earlier date in the season. General farming or dairying are the chief types of farming found.

The rotation most commonly practiced consists of small grain, followed by clover, or clover and timothy, followed by corn. The only fertilizer used on this soil to any extent is stable manure. In addition to this, the plowing under of a green manuring crop is now receiving some attention. Commercial fertilizers

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*For chemical composition and improvement of this soil, see page 36.

are not used to any extent, but tests made elsewhere indicate that this soil will respond with profit to the use of phosphate fertilizers.

SUPERIOR FINE SANDY LOAM.

The surface soil of this type to a depth of from eight to ten inches consists of a loose friable loam, or fine sandy loam of a dark brown color. It usually becomes somewhat lighter in color and coarser in texture to a depth of from twelve to twenty inches where the heavy red clay characteristic to this series is found. This heavy subsoil frequently contains thin seams of fine and very fine sand, and in places it is also common to find a very small amount of limestone fragments through it. The depth of the heavy subsoil is somewhat variable ranging from eight to twenty-four inches.

This soil is of limited extent, and most of the areas, all of which are small, are scattered through the towns of Center, Freedom, Kaukauna, Greenville and Grand Chute.

The surface of this soil is level, with only a very few undulations. The natural drainage is somewhat deficient because of the heavy subsoil, but is somewhat better than the drainage of the heavier types of this series. Tile drains could be profitably installed over a considerable proportion of this type, however. The original timber growth consisted largely of maple birch, with a small amount of elm, some hemlock, and pine.

The greater part of this soil has been cleared, and placed under cultivation, and the farm crops common to the region are being grown successfully upon it. Because of its limited extent, there are but few, if any, farms located entirely upon this soil.

In the improvement of Superior fine sandy loam, drainage is a factor which must be considered in many cases, but in some instances tile drains are not necessary.

The supplying of additional organic matter should be considered, however, and the plowing under of a legume crop will greatly assist in this direction.*

*For chemical composition and improvement of this soil, see page 36.

SHOWING SURFACE FEATURES OF SUPERIOR FINE SANDY LOAM, ROLLING PHASE.

This is excellent soil, and one of the extensive types in the county.

SHOWING SAND BLOWN INTO LOW DUNES BY THE WIND.

This condition is not extensive in Outagamie Ciunty. This poor sandy soil shows a very marked contrast to the highly improved land immediately adjacent to it.

SUPERIOR FINE SANDY LOAM.

ROLLING PHASE.

Extent and distribution.—This soil is the most widely distributed type, being found in every town in the county. It is most extensively found in the southwestern quarter of the county, and predominates in the towns of Dale, the western part of Hortonia, and Maple Creek.

Description.—The surface soil to an average depth of eight inches is a brown to a rather dark brown mellow fine sandy loam. Immediately below this depth the color becomes somewhat lighter, frequently being a pale yellow. At about eighteen inches, heavy compact red clay is encountered. This continues to a depth which is undetermined, but which is always much more than three feet. The chief variation in this soil is in the depth of the sandy material over the red clay. This may range from eight to about twenty-four inches. There is also some variation in the texture of the surface material, there being a few places which could be classed as sandy loam, and again where it approaches a loam in texture. Such variations are too limited to be indicated, however.

While stones are not common on this soil, a few limestone bowlders were found. Wherever they occur in sufficient numbers to interfere to any extent with farming operations, appropriate symbols have been placed upon the soil map. In the soil section and chiefly in the second and third foot below the surface, fragments of partially decomposed limestone may sometimes be found.

Topography and drainage.—The surface of this soil ranges from undulating to rolling, and the natural drainage is good. The drainage is much better on this soil than on the silt and clay loam types.

Present agricultural development.—While there are still a few wood lots on this soil, by far the greater part of it has been cleared, placed under cultivation, and is now in highly improved farms. In fact, where this soil predominates, is found to be some of the most highly improved and prosperous farming communities in the county. All of the general crops common to the region are grown successfully. Potatoes are also grown more commonly on this soil than on the heavier types of the region. Alfalfa is also a crop which does well, and which is being grown

to a larger extent every year. This soil is adapted to a somewhat wider range of crops than the heavier soils, and is more desirable because it can be worked under a wider range of moisture conditions. Its sandy surface permits it to drain out and warm up earlier in the season; so crops on this soil will frequently have a week or ten days and sometimes even more advantage over crops grown on the heavy, and especially, heavy and level soils.*

MIAMI LOAM.

The surface soil of this type consists of a brown or dark brown friable mellow loam extending to a depth of about eight inches. The subsoil usually consists of a fine sandy loam carrying a small amount of fine gravel. The underlying rock is frequently found at a depth of from fifteen to thirty inches, and frequently immediately above the rock there is a layer of heavy somewhat reddish material which is probably residual from limestone. This soil is quite variable, ranging from a silt loam to a fine sandy loam which is inclined in places to be somewhat gravelly. The subsoil is also variable, ranging from a sandy loam to a loam or even a clay loam. This type is of very limited extent and of minor importance. It occupies considerably less than one square mile, and probably the most important area is found near the center of the town of Freedom. Only a few other scattered areas occur in the county.

The surface is gently rolling, and the natural drainage is good. The soil is of glacial origin, and the native timber growth is practically the same as on the Superior soils.

This is an excellent agricultural soil, but because of its limited extent, but few if any farms are located entirely upon it.

In its crop producing power and general agricultural value, it compares very favorably with the best soils of the Superior series.*

MIAMI FINE SANDY LOAM.

Extent and distribution.—The largest area of this soil is found near the center of the county from three to seven miles

*For data on chemical composition and fertility, see page 36.

southwest of Black Creek in the towns of Black Creek, Bovina, and Ellington. The total area is approximately ten square miles. Aside from this rather extensive tract there are numerous other scattered areas of very limited extent.

Description.—The surface soil of this type to a depth of about ten inches consists of a brown to grayish-brown mellow fine sandy loam. The subsoil becomes somewhat lighter in color, and usually a little coarser in texture with depth. At twenty to twenty-four inches it is usually a yellowish fine sand or fine sandy loam which may contain considerable fine gravel and limestone particles.

The surface soil is inclined to be somewhat variable, but in most instances it can be classed as a fine sandy loam. In a number of places there is considerable gravel on the surface and where this is the case, symbols have been used to show this condition. Wherever bowlders occur on the surface in sufficient numbers to interfere with farm operations, these have also been shown by symbols.

There is also some variation in the subsoil. A material of a loam of clay loam texture is sometimes found in the lower depths.

Topography and drainage.—The surface of this soil ranges from undulating to gently rolling, and in a few cases it is somewhat irregular or bumpy. In a few instances, the underlying rock occurs rather close to the surface, as for example, directly north of Stevensville where there is quite an elevation, the core of the hill being made up of limestone. Because of the uneven surface features and the rather open subsoil, the natural drainage of this soil is good.

Present agricultural development.—*Practically all of the timber has been removed, and most of the type is now in well improved farms. This is a soil which is easily cultivated, and one which has a fair to good agricultural value. All of the general farm crops common to this region are successfully grown upon it, and the yields secured compare favorably with those obtained upon the Superior fine sandy loam, rolling phase. The general farm processes followed, the rotations, methods of agriculture, fertilizers, etc., and the lines along which this soil could be best improved are practically the same as for the Superior fine sandy loam, rolling phase.

*For data on chemical composition and fertility of this soil, see page 36.

ANTIGO FINE SANDY LOAM.

Extent and distribution.—This type is closely associated with the Antigo loam, but is a little greater in extent. It is confined to the northwestern part of the county where it is found in the broad flat plains bordering the Embarrass, Wolf, and Shioc Rivers. A large area occurs in Deer Creek Township, northeast of Bear Creek, and another in Bovina Township north of Shiocton. The former is a little lighter in texture than the typical.

Because of its very limited extent, there has been included with the Antigo fine sandy loam a few small areas of Fox fine sandy loam. The most important tract is found in section 7 in the town of Dale. It differs from the Antigo type chiefly in being somewhat coarser in texture, and also in having a somewhat different origin, it having been derived from glaciated limestone material. It may have a slightly higher agricultural value than the Antigo since it is seldom acid, while most of the Antigo soils are acid.

Description.—The surface soil of the Antigo fine sandy loam to a depth of from six to eight inches is a brown to dark brown, loose, friable very fine sandy loam free from stones and gravel and carrying a fair amount of organic matter.

The subsoil grades very rapidly into a yellowish brown to pale yellow very fine sand of undetermined depth.

Topography and drainage.—The topography of the Antigo fine sandy loam is flat to very gently undulating. The surface is only a few feet above the usual high water mark of the neighboring streams; so after unusually heavy rains some of this type is subject to overflow. Owing to the loose character of the soil and the sandy subsoil, the drainage is fairly good. However, when the water in the streams is high, the water table of the soil is close to the surface.

Present agricultural development.—*It is a good agricultural soil. Over ninety per cent of this type is under cultivation. General farming and dairying are the prevailing forms of agriculture, although in the vicinity of Shiocton truck farming has come into prominence. Of the general farm crops, hay, oats, corn, barley, and rye are the most common. Hay does not yield quite as well as on the Antigo loam although yields of from 1½

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*For data on chemical composition and fertility of this soil, see page 36.

to 3 tons per acre per year are not unusual where good practices are followed. Oats yield a little less than on the Antigo loam, average yields being from thirty to fifty bushels per acre. A rotation similar to that used on the Antigo loam is practiced by the farmers on the type. Potatoes are grown to some extent, and yield from 100 to 150 bushels per acre.

Of the special crops grown, cabbage, sugar beets, and onions are by far the most important. Of these cabbage ranks first. Where good farm practices are followed, average yields of from eight to twelve tons per acre are obtained. Sugar beets yield from six to twelve tons per acre, and onions from 150 to 350 bushels per acre.

The Antigo fine sandy loam is very easy to cultivate, and except under very unfavorable moisture conditions no difficulty is experienced in the preparation of a good seed bed.

ANTIGO LOAM.

Extent and distribution.—The Antigo loam is closely associated with the Antigo fine sandy loam, although it is of smaller extent. It is confined to the northwestern part of the county, where it is found in the broad flat plains bordering the Embarrass, Wolf, and Shioc Rivers. The largest areas occur in Deer Creek and Maple Creek Townships.

Description.—The surface soil of the Antigo loam for about eight to ten inches is a dark brown friable loam free from stones and gravel, and carrying a large percentage of very fine sand with considerable organic matter. The subsoil grades rapidly into a yellowish-brown very fine sand which becomes a pale yellow at about twenty-four inches. This continues to below four feet.

In places the soil becomes nearly a silt loam, and where this is the case, the sandy subsoil is not encountered until about twenty-four inches. A small area of the heavier phase is located just southwest of Helena, and another southeast of Bear Creek in Deer Creek Township.

Topography and drainage.—In topography the Antigo loam is flat, to very gently undulating. The surface is only a few feet above the usual high water mark of the neighboring streams; so after unusually heavy rains, portions of this type are inundated.

Owing to the sandy character of the subsoil the drainage is

usually fairly good, except when the rivers are high. At these times the water table is close to the surface.

Present agricultural development.—Practically all of this type is under cultivation. General farming and dairying are the prevailing forms of agriculture. The soil is well adapted to hay and oats, while all of the general farm crops common to the region do fairly well. It is not as well adapted to potatoes as is the Antigo fine sandy loam. Corn does not do well after wet spring as the ground remains cold until late in the season, and the high water table retards the development of the root system.

Of the special crops, cabbage and sugar beets are yielding the growers satisfactory returns. Cabbage yields from eight to fifteen tons and sugar beets six to twelve tons an acre.

Where good methods of farming are being followed the productivity of the soil is gradually being increased, but where careless methods are practiced, the yields are gradually declining. Spring wheat was formerly grown with good success, but the yields became poorer and poorer until the crop was finally abandoned over most of the area. Good farmers practice a rotation consisting of corn, followed by a small grain, such as oats, or barley, and then seeding with clover and timothy. Hay is cut for one or two years, and is usually pastured a year, after which it is manured and then plowed for corn.

The Antigo loam is comparatively easy to cultivate and when worked under favorable moisture conditions, no difficulty is experienced in securing a good seed bed. It is usually best to fall plow, for if the spring is wet, some difficulty may be experienced in getting the crop sown on time.

CHEMICAL COMPOSITION AND FERTILITY OF LOAMS AND FINE SANDY LOAMS.

These soils are only a little more open in texture than the silt and clay loam types. They have a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which they contain reduces the water content of the surface somewhat so that they warm up more readily in the spring and have less tendency to bake and crack than the heavier soils. These qualities make them better adapted to such crops as corn and potatoes than are the heavier soils.

The total amount of the plant food elements, phosphorus and potassium, is nearly if not quite as large in the fine sandy loams as in the silt loams. However, they have rather less organic matter, and this, together with the somewhat coarser texture, results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of active organic matter is of the utmost importance. A high degree of fertility cannot be maintained in these soils unless about twice as large an amount of organic matter is developed in them as that which they originally have. The plowing under of legumes, such as a second crop of clover or a crop of soybeans, is the best method of producing this result. The application of phosphorus and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

The degree of acidity in the Antigo soils is seldom more than "slight" in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of all crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in the virgin condition acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop, and also to watch the growth of clover carefully from year to year, so as to begin the

use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

The Superior and Miami soils of this group have been derived from materials which contain varying amounts of lime carbonate. The subsoils are usually well supplied with lime, but the surface soils frequently show varying degrees of acidity, due partly to the long period of leaching to which they have been subjected. The degree of acidity is seldom as great as on the Antigo soils, however.

These types of soils are well adapted to general farming and some special crops such as potatoes can also be grown to good advantage. These soils which are of intermediate texture are better adapted to potato culture than are the heavier types on the one hand or the light sandy soils on the other. It is necessary to give these soils somewhat more attention to maintain their fertility than the heavier types partly because they are lower in fertility, but more because of the fact that these special crops require a higher degree of fertility to produce satisfactory yields. When these soils are used for special crops the fertility can best be maintained by rather heavy applications of stable manure, or through the use of a rotation in which a legume is grown as the means of securing the organic matter and nitrogen, while the other elements chiefly phosphorus and potassium, are supplied in the form of commercial fertilizers. When the latter system is used one-third or one-fourth of the land should be sown to a legume and a part of the commercial fertilizer used on this crop. The fertility used in this way would become available to succeeding crops through the decomposition of the legume when plowed under. The remainder of the fertilizer would be applied at the time of fitting the soil for the succeeding crops.

CHAPTER IV.

GROUP OF FINE SANDY SOILS.

COLOMA FINE SAND.

Extent and distribution.—This type is comparatively small in extent, and of minor importance from an agricultural standpoint. It is mainly confined to the northwestern part of the county, the chief areas occurring in the vicinity of Hortonville and Stephensville. Other small isolated areas are found scattered throughout the county, usually occurring as small hilltops or ridges.

Description.—The surface soil of the Coloma fine sand to a depth of from eight to twelve inches is a grayish brown loose, open fine sand, containing but little organic matter. The subsoil is a loose fine sand continuing to over three feet, and grading from a light brown to a yellowish brown or pale yellow in the lower depths. Gravel beds covered by a thin mantle of surface soil are often found throughout the type.

The organic matter content varies over different sections of the type, being higher in the depressions where the moisture conditions have favored an accumulation of humus-forming material. Dunes formed by wind blown sand are occasionally found.

There are several variations which have been included with this soil, but which, had they been of any important extent, would have been mapped as separate types. In the northwestern part of the county, chiefly in the town of Maine, there are numerous small tracts of light-colored soil which has a very fine sandy texture. It is loose and open in structure, and usually entirely free from stones and gravel. The subsoil is a yellowish brown or yellow very fine sand which extends to an undetermined depth. This material differs from the typical Coloma fine sand only in being finer in texture. Because of this finer texture, it probably has a somewhat higher agricultural value, although this is not apparent from the crop yields which are now being secured.

Another variation occurs in the town of Liberty in sections 13 and 14, and also in a number of other localities, but always in small patches. This soil is the same as the Coloma fine sand to a depth of 24 to 36 inches where it is underlain by the red clay typical of the Superior series. Because of this underlying clay, this phase is a better soil than the typical, and would have been mapped as the Superior fine sand or fine sandy loam, rolling phase, had it been of sufficient extent.

Topography and drainage.—The topography of this type ranges from undulating to hilly. On account of its loose, open structure, the natural drainage is somewhat excessive, and the type is very liable to suffer from drought except during seasons of excessive rainfall.

Present agricultural development.—*Over seventy-five per cent of the Coloma fine sand is under cultivation to the general farm crops common to this region. Corn gives an average yield of about twenty bushels, oats fifteen to twenty bushels, rye twelve bushels, timothy and clover three-fourths to one ton, and potatoes from fifty to one hundred bushels an acre. By careful cultivation, rotation, and fertilization, these yields have been more than doubled by some farmers.

Over most of this type but little attention is given to the selection of a rotation particularly adapted to this soil. The methods of cultivation are similar to those followed on other sandy types of the county. The soil is loose and open, and is very easily cultivated.

It may be said of this type as a whole that the methods now followed upon it are not such as tend to increase its productivity, although there are exceptions where more up-to-date methods are being practiced.

COLOMA FINE SANDY LOAM.

The surface soil of this type to an average depth of eight to ten inches consists of a light brown to grayish brown fine sandy loam, which rests upon a subsoil of about the same texture, but having a somewhat lighter color. In the lower depths, the material is usually a fine yellow sand, with which varying amounts of fine gravel may be found. The material is quite uniform in texture, and is stone free.

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*For chemical composition and fertility of this soil see page 42.

The type is of limited extent and of minor importance. It occurs in small scattered tracts, the most important of which are found in Grand Chute and Maine Townships.

The surface is undulating to gently rolling and because of the sandy nature of the material the natural drainage is good and frequently excessive.

The original timber growth was mixed pine and hardwood, with hardwoods predominating. Practically all of the original timber has been removed.

This is a soil of only medium to fair agricultural value. It is deficient in organic matter and mineral plant foods, but its texture is such that by growing green manuring crops, following good crop rotations, and using proper fertilizers it can be built up into a profitably producing soil. Small grain, clover, and potatoes are a good rotation for this kind of land, with the second crop of clover plowed down. Liming will help in getting clover started and commercial fertilizers can also be used with profit. A 2-10-4 will give good results. From 150 to 200 pounds per acre should be applied to corn or small grain crops. Potatoes should have larger applications.

This soil has been included with the group of fine sands because in its agricultural value it more nearly approaches these soils than the group of loams and fine sandy loams, which usually have heavy subsoils.

PLAINFIELD FINE SAND.

The surface soil of this type to an average depth of eight inches consists of a loose, grayish-brown, very fine sand which contains but little organic matter. It is entirely free from gravel and stones. Below eight inches the material becomes lighter in color, usually being a pale yellow or yellowish-brown. The texture continues a very fine sand to undetermined depth.

This soil is of very limited extent, but is found in a number of small tracts in several regions, chiefly in Maine, Deer Creek, and Bovina Townships.

The surface is level or only gently undulating with some minor irregularities caused by wind action. In many places the water table is not far below the surface, so that during part of the year the drainage is none too good. When the streams are low, the loose, open character of the material permits the free movement of water through the soil, and the type often suffers from lack of moisture during the dry portion of the summer.

This soil is of minor importance because of its limited extent and also because of its rather low value from the standpoint of crop production. While part of it is under cultivation, the yields are low. It is low in organic matter, and the mineral plant food elements.

CHEMICAL COMPOSITION AND FERTILITY OF FINE SANDS

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn, and potatoes. find sufficient moisture during average seasons and suffer from drought only during periods of relatively low rainfall.

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds. The total potassium of the surface eight inches per acre is approximately 25,000 pounds or but little over one-half of that found in heavier soils such as the Superior silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface eight inches and from one to two per cent in the second eight inches. They have a correspondingly low nitrogen content averaging from 1,000 to 1,500 pounds in the surface eight inches. This organic matter is largely in the form of leaf-mold and fine roots, and it decomposes quickly when the surface is first broken, furnishing a limited supply of nitrogen for a growth of crops. However, it is exhausted with comparative readiness and the most important point in the management of all of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases, and for the best growth of clover and especially alfalfa liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover, but assists in preventing the leaching of phosphorus and maintaining it in a form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown, and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other live stock farming is prac-

ticed it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soybeans or clover, occasionally, all of which is to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necessary to maintain the soil productivity. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover, and there is little loss in so doing, since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The use of lime in some form and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown, and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils, it must not be considered that this is an indication that they have less value than heavier soils which are relatively higher in these elements, for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts and the finer tilth which these fine sands develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops. For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletins 204, 230 and 341 of the Experiment Station.

CHAPTER V.

GROUP OF POORLY DRAINED SOILS.

POYGAN CLAY LOAM.

This type is of very small extent. Small areas are found near the center and southeastern parts of the county, the largest of these occurring north of Stephensville in Ellington Township. It is closely associated with the Superior clay loam and silt loam, and occupies depressions and low, gently sloping areas bordering streams.

The surface soil of the Poygan clay loam to a depth of from eight to fifteen inches is a dark brown to black, sticky compact clay loam, rich in organic matter. The subsoil becomes lighter in color for a few inches before grading into pinkish-red clay at from fifteen to twenty inches. This clay is very compact and tenacious and extends to an undetermined depth.

In topography the Poygan clay loam is flat to gently sloping. The surface is low which coupled with the impervious character of the subsoil makes the natural drainage very poor.

Less than half of this type is under cultivation. The greater part of it is badly in need of drainage, and in its present condition is valuable only as pasture and for the marsh hay which may be cut. Where the type has been properly drained, it has a high agricultural value. It is especially adapted to hay and small grains, while corn and other crops common to the region do well. It is rather heavy for potatoes, but cabbage and sugar beets are grown with fair success.

POYGAN SILT LOAM.

No areas of Poygan silt loam of any great extent are found, although small patches of the type occur scattered throughout practically every township in the county. It is closely associ-

ated with the soils of the Superior series, and occupies depressions and flat areas bordering streams and marshes.

The surface soil of the Poygan silt loam to a depth of from eight to ten inches is a dark brown to black sticky, compact silt loam, rich in organic matter. The subsoil becomes lighter in color for a few inches before grading into the heavy tenacious red clay subsoil at from twelve to fifteen inches.

In places the red color of the subsoil may entirely disappear, but the texture and other characteristics remain the same. The blue clay subsoil areas are too small to be mapped out separately.

In topography the type is flat to gently sloping. The surface is low, and the subsoil is quite impervious to water which makes the natural drainage very poor.

The original forest growth consisted principally of black ash, elm, maple, with some oak, hickory, poplar, birch, alders, etc. In most places the valuable timber has been removed.

Very little of this type is under cultivation. The greater part of it is badly in need of drainage; so in its present condition, it is valuable chiefly as pasture land. Where the type has been properly drained, it has a high agricultural value. It is not well adapted to potatoes, but other crops common to the region and small grains, grasses, cabbage, sugar beets, etc., do well.*

POYGAN FINE SANDY LOAM.

This type is of very small extent. It is usually associated with the Poygan silt loam, or the Superior fine sandy loam. Small isolated areas are found scattered throughout the county where it occupies depressions and gentle slopes bordering streams or marshes.

The surface soil of the Poygan fine sandy loam to a depth of about seven inches is a dark brown to black, friable mellow, fine sandy loam, carrying a relatively high per cent of organic matter. The subsoil for three or four inches usually is a fine sand, to very light fine sandy loam, which then grades into a pinkish-red clay loam to clay.

The topography of the type is flat to gently sloping. The surface is low and the natural drainage is poor.

*For data on chemical composition and improvement of this soil, see page 46.

The timber growth consisted of ash, elm, maple, with some oak, hickory, birch, willow, poplar, alders, etc. The best timber has been removed. But very little of this type is under cultivation. When well drained, it yields fair results when the crops common to the region are grown. It is an easier soil to handle than the Poygan silt loam and clay loam, but the yields, especially of grains and hay, are not as large.

CHEMICAL COMPOSITION AND FERTILITY OF POYGAN CLAY LOAM, SILT LOAM, AND FINE SANDY LOAM.

These soils have relatively large amounts of organic matter accumulated as a result of poor drainage. The supply of phosphorus is usually fairly high, but in some cases it is not readily available. Its availability will depend largely upon the rate of decomposition of the organic matter. The total amount of potassium is fair in the fine sandy loam, and large in the silt loam and clay loam, but the chief question here also is regarding its availability.

While soils well supplied with vegetable matter as these are do not need special treatment with reference to potassium and phosphorus immediately after reclamation, they very generally do show a need of care in this regard within a few years, and patches of these types frequently fail to produce satisfactory crops even immediately after drainage and breaking unless stable manure or special mineral fertilizers are used.

In the improvement of these types the first step is, of course, drainage. Both open ditches and tile drains can be installed to advantage. Plowing fields in narrow lands with dead furrows two to four rods apart, and having these lead into shallow open ditches along the side of the field, will greatly assist in carrying off surface water. In order to make the internal drainage of the soil complete, however, tile drains should be used to supplement the surface ditches.

With thorough drainage these soils will be adapted to a wide range of general crops. Special crops such as cabbage and sugar beets are well suited to these lands when drained.

WHITMAN LOAM.

Extent and distribution.—This type is of small extent, occupying less than ten square miles in the county. The two largest

areas occur in Bovina township, one west and the other northeast of Shiocton. Other small, isolated areas are found scattered about in the northwestern part of the county.

Description.—The surface soil of the Whitman loam to a depth of about seven inches is a dark brown to black, mellow, friable loam rich in organic matter. It carries considerable silt, and sometimes considerable very fine sand. It is free from stones and gravel. The subsoil rapidly becomes lighter in color and coarser in texture, until at about fifteen inches it is a yellowish brown to pale yellow very fine sand. This continues to well over three feet.

In places the subsoil will carry a little sandy clay which is a mottled drab, yellow and brown color, but such areas are very small.

Topography and drainage.—The topography is level, which with the low position of the type, makes the natural drainage poor. The water table is usually within a few feet of the surface and during the spring the soil is almost completely saturated. At times, portions of the type are several inches under water. In places open ditches have been constructed.

Present agricultural development.—Where properly drained, the general farm crops common to the region are grown and excellent yields obtained. About half of the type is under cultivation. Of the special crops, cabbage, beets, and onions do well, and some celery has been successfully grown. The chief requirement of the land is good drainage. The undeveloped portion of the type is valuable only for the pasture it affords, and the marsh hay which may be cut.

Chemical composition and fertility.—The Whitman loam is quite similar to the Clyde loam of southeastern Wisconsin, differing chiefly by being acid, while the Clyde soils are not acid. It also carries a larger proportion of very fine sand than does the Clyde loam. From the standpoint of the plant food elements which it contains, this may be considered a well-balanced soil.

The Whitman loam contains from three to five times as much nitrogen and organic matter as does the average light-colored upland soil of this region. It contains from 1,500 to 2,000 pounds of phosphorus in the surface eight inches an acre, and from 40,000 to 45,000 pounds of potassium.

In the improvement of this type the first step is to supply adequate drainage. Open ditches will not be sufficient by themselves, and should be supplemented by the use of tile drains. When well drained, this will become one of the strongest and most productive soils in Outagamie County. Because of the low position of some of this type, its improvement would at present require diking, which, under present conditions, would not be justified.

DUNNING FINE SANDY LOAM.

The surface soil of the Dunning fine sandy loam to a depth of from four to seven inches is a dark brown to black, loose, friable, very fine sandy loam, free from stones and gravel, and carrying a high percentage of organic matter. The subsoil grades abruptly into a pale yellow very fine sand, which continues to well over three feet.

This type is of small extent and of minor importance. It occurs only in small isolated areas scattered throughout the northwestern part of the county. The main areas occur in the eastern half of Maine Township.

The topography is level, which with the low position of the type makes the natural drainage poor. The water table lies close to the surface, and for portions of the year parts of the type may be covered with a few inches of water.

The timber growth consists mainly of alders, quaking aspen, birch, and some maple, elm, and black ash. Practically all of the good timber has been removed, but a dense second growth covers most of the area. Very little of this type is under cultivation. The principal crops are oats, timothy hay, and marsh grass. On small areas which have been properly drained, cabbage and onions are being grown successfully.

Chemical composition and fertility.—The Dunning fine sandy loam is well supplied with nitrogen and organic matter in the surface soil, but it is usually deficient in the mineral plant foods, phosphorus and potassium. The greatest deficiency is drainage, however, and before cultivated crops can be grown successfully, a thorough system of drains must be provided. Open ditches as now installed in some places are not sufficient in themselves, and must be supplemented either by open laterals or tile drains. When drainage has been provided, it will be found that the

most economical and profitable crop production can be secured by the use of mineral fertilizers containing phosphorus and potash. Such crops as alsike clover and timothy, buckwheat, and corn may be expected to give good results on this kind of land under good management. Corn may not always mature because of the danger from frosts on the low land, but one is reasonably certain of always securing good silage.

CLYDE SILT LOAM.

The surface soil of this type to a depth of about eight inches consists of a black friable silt loam which contains a very large amount of organic matter. The subsoil begins as a dark-colored silt loam to about twelve or fourteen inches, when it becomes somewhat lighter in color, frequently being of a grayish or blue tinge and also being lighter in texture. The subsoil is quite variable, but is most often sandy loam below eighteen inches. In a few instances it was found to be a very fine sand which was mottled in color.

There are some variations, but the most important one is where the surface is really a clay loam, and the subsoil a heavy bluish silty clay loam with lenses of sand in the lower subsoil. This phase could justly be classed as Clyde clay loam, except that its very limited extent makes it of little importance. This type is of limited extent and of minor importance. It is confined to the eastern and southern parts of the county, and occurs in a number of widely separated areas. One of these, and perhaps the largest, occurs in Section 15 in the town of Osborn. Other areas are found in Sections 22, 23, and 24, in the town of Ellington, and in Section 6 in the town of Center. Several other small tracts occur in the town of Dale. The surface of this soil is level or having only a very gentle slope. Because of its low position and level surface, the natural drainage is very poor, and before it can be used for cultivated crops drainage is necessary.

But very little of this land has been cleared and placed under cultivation, owing to the fact that its drainage is very deficient. The best timber has been removed, and some of this land is now being used as pasture land. Where it is possible to drain this soil, it can be made very excellent land.

In the improvement of this soil, drainage is the first consideration. From the standpoint of the amount of plant food which

it contains, it is a well-balanced soil, and when drained will be adapted to a wide range of crop production. Sugar beets and cabbage are special crops which do well on this soil.

CLYDE FINE SANDY LOAM.

The surface of this soil consists of a dark brown or nearly black fine sandy loam to a depth of about eight inches. The subsoil is a fine sand, or fine sandy loam, extending to a depth of over two feet. In color the subsoil is a little lighter than the surface and may consist of a gray or yellowish, or sometimes mottle material.

This type is of limited extent, occupying less than two square miles. It is found in small scattered areas chiefly in the towns of Bovina, Osborn, and Ellington. The surface is low and level, and the natural drainage is very poor. This soil has the same origin as the Clyde silt loam, and supported practically the same original timber growth.

There is but very little of this soil improved at present because of its poor drainage, and before it can be used for cultivated crops drainage is necessary.

GENESEE SILT LOAM.

The surface soil of the Genesee silt loam consists of about eight inches of brown, friable, silt loam, which at times carries a considerable quantity of very fine sand, and is usually comparatively high in organic matter.

The subsoil is a light brown loam to silt loam, which usually becomes lighter in color with increase in depth until at twenty-four inches it is a pale yellow to yellowish brown.

The type is subject to considerable variation in texture and depth. The subsoil is sometimes sticky, although it often carries large quantities of fine sand, and may grade entirely into fine sand at from two to three feet. Small areas of shallow peat and fine sand are encountered, although none of these variations are large enough to be indicated on the soil map.

This type is confined chiefly to the valleys of the Embarrass, Wolf, and Shioc Rivers, although it is found to some extent along practically all of the streams in the northern and western parts of the county.

The topography is level except where old stream channels cut across the type in numerous places. The surface is low, subject to annual overflow, and is usually wet during the spring and early summer months. During dry spells when the streams are low, the soil is fairly well drained.

The material forming this soil is of alluvial origin, derived from sandstone and granitic rock debris.

The forest growth consisted chiefly of swamp oak, elm, basswood, maple, and ash with some willow. The best of the timber has been removed, although there is still a good stand of trees over most of the area, and in places a dense undergrowth including alders is encountered.

All of this type is subject to overflow. For this reason, little attempt at improvement has been made. Aside from the marsh hay which can be cut from a portion of the type and the pasture which it affords, it has but little present agricultural value.

If protected from overflow, this type would have a high agricultural value. A proposed canal, designed to carry the excess water from the Wolf River, across the northern part of the county into Duck Creek, if brought into successful operation would solve to a large degree, the difficulty which has been encountered in the improvement of this type.

GENESEE FINE SANDY LOAM.

The surface soil of the Genesee fine sandy loam consists of about eight inches of brown, friable, very fine sandy loam. The subsoil is a little darker in color, but the texture usually remains the same to below three feet. In places very fine sand is encountered at from eighteen to twenty-four inches.

Small areas of fine sand and shallow peat are encountered, although none of these variations are large enough to be indicated on the soil map.

This type is confined chiefly to the valley of the Wolf River, where it occupies low flats bordering the stream. The surface is low, subject to annual overflow, and is usually wet during the spring and early summer months. During dry spells when the stream is low, the soil is well drained.

The best of the timber has been removed, but there still remains a good stand of trees, and in many places dense undergrowths are encountered. As all of this type is subject to over-

flow, little attempt at improvement has been made. Aside from the marsh hay which may be cut from a portion of the type, and the pasture which it affords, it has a very low agricultural value. In all respects it is very similar to the Genesee silt loam, except that the latter is higher in organic matter, and has a finer texture.

The drainage of this type under present conditions would be very difficult in most cases, and it is probable that it will not be improved for a long time, except for a few patches of the type which are more favorably located than the average. With good drainage, it will make a productive soil, adapted to a wide range in crop production.

PEAT.

The material mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a very raw fibrous condition, showing quite plainly the structure of the vegetable growth from which it is derived. In a fibrous condition the material is brown, but with decomposition its color becomes darker, and where thoroughly decayed it is black or very dark brown. Mineral matter may be incorporated with the organic matter, but seldom in sufficient quantities to appreciably offset the texture. In the more extensive areas of Peat there is little or no mineral matter except about the margins, where the proportion is frequently sufficient to form muck. The mucky areas are too small to be satisfactorily separated, however, and are included with the Peat.

The depth of Peat is variable. The areas in which it is less than eighteen inches are separated as a shallow phase. In some places the organic deposits are more than ten feet deep and in practically all the swamps with an area of one square mile or more, the depth is more than three feet. It is generally deepest in the center of the areas, and shallowest about the margins.

In large swamps and marshes where the material is still raw, there is very little difference in character between the surface material and the material several feet below the surface. Where conditions have favored rapid decomposition the material at the surface is frequently darker than that at lower depths, but where the accumulation of vegetable matter on the surface has been rapid, the lower depths are more decomposed and darker in color. A profile section may consist of eight to sixteen inches

of slightly decomposed to well decomposed brown to dark brown vegetable matter, underlain by similar material which may be more decomposed, or may be in a very raw condition.

The material underlying the peaty matter is variable, and ranges from sand to silt loam or clay loam. In general, its texture is determined largely by that of the surrounding upland soil. In the regions of silt loam soils the underlying material is usually heavy and of a grayish to dark brown color. Throughout the sandy sections in most cases the peaty material is underlain by grayish to nearly white sand to very fine sand.

In places small islands of Muck, sand, or other soils have been included with the Peat. Such areas were too small and unimportant to be separated.

Areas of Peat are distributed through all parts of the county, but are most extensive in the northwestern part. The largest areas occur in the townships of Black Creek, Bovina, Liberty, and Hortonia.

Practically all the Peat areas are level, or have only a very gentle slope. The slope is nowhere sufficient to drain the material without the use of open ditches. Most of the areas of Peat are wet the greater part of the year, and there are often a few inches of water over the surface in the spring when heavy rains occur.

Most of the marshes in which Peat occurs have sufficient slope to be successfully drained. In a few instances drainage districts have been organized, and rather extensive drainage projects are being developed. However, at present very little of the Peat is under cultivation, and its agricultural value in its present state is low.

The native trees of the Peat consisted chiefly of tamarack and cedar. Some of the marshes do not support any trees or have only scattered growths of tamarack, cedar, ash, etc. In most of these places the original timber has been destroyed by fire, though a few marshes apparently have always been treeless. On some of the open marshes there is a coarse grass which is cut for hay, but in most cases the vegetation consists of moss, blueberry bushes, and other moisture-loving plants.

PEAT, SHALLOW PHASE.

Peat, shallow phase, is differentiated from the typical peat, solely on the basis of the thickness of the peaty deposit, the maximum in the phase being eighteen inches. The underlying material is very variable, and usually corresponds quite closely to the surrounding uplands. In regions where the surrounding soils are heavy, the subsoil is usually a silt loam or clay loam, often mottled in color. Where the uplands are sandy, the material composing the subsoil is usually light, consisting of fine sandy loam to very fine sand. The depth of the peaty material is also variable, and ranges from six to eighteen inches.

In places small islands of muck, sand, or other soils have been included with the peat. These areas were too small and unimportant to be mapped separately.

The shallow phase of Peat is not very extensive and occurs only in small areas scattered throughout the county.

The timber growth of this phase is practically the same as for the typical Peat, with the exception of tamarack. This tree is found only in a few places on shallow Peat.

The production of marsh hay is about the only use made of this soil at present. It is used to a small extent for grazing. In its present condition it has a low agricultural value. When drained it will be adapted to the same crops and types of farming as the typical Peat.

In most cases it is easier to improve the shallow phase as it will be more easily drained, and will require less compacting to make a good seed bed.

CHEMICAL COMPOSITION AND FERTILITY OF PEAT SOILS.

In the improvement of the peat lands of Outagamie County, the first step is drainage. With the exception of some of the marsh land immediately adjoining some of the larger streams, it is thought that most of the marshes could be readily drained and successfully cultivated. Along some of the larger streams, the surface of the Peat is so low that much of it would require diking, or the lowering of the bed of the stream, which would be very expensive and hardly justifyable under present conditions.

The crops adapted to this land depend to a considerable extent on the degree of drainage secured, and on the thorough-

ness with which the ground is prepared. A much less expensive and complete drainage system would be necessary to fit this land for tame hay such as timothy and alsike clover than would be needed to fit it for corn, sugar beets and other cultivated crops. For its highest development agriculturally, a tile drainage system in which the laterals are not more than eight to ten rods apart would be essential.

The chief difference between peat soils and upland soils consisting largely of earthly matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average percentage of phosphorus in the peats of this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot there is approximately only 675 pounds, or in two feet 1,350 pounds, in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average of 0.3 per cent of this element, while good upland clay loam soils average 2 per cent, or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3,000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent and this only in the surface eight inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and potash. These elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well

as peat, the manure should be used on the upland soils and commercial fertilizers containing phosphorus and potash used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

Crops and system of farming on marsh lands.—Since the growth of corn and potatoes to which these marsh lands would otherwise be well adapted, is limited in this section on account of the danger from frost, the best staple crops for this land are grasses for hay and pasture, hardy root crops, and rye and, to a less extent, oats. When properly fertilized and limed, clover, alfalfa, and other legumes can also be grown. On fairly well drained marsh land not too raw good pasture can also be developed. The compacting of the soil resulting from the use of this land as pasture is also a great benefit to it. When peat land is placed under cultivation a heavy roller should be classed along with implements necessary to its successful management.

On account of the crops to which this land is adapted and its use as a pasture, marsh lands can be used for dairying or stock raising to good advantage.

Certain special crops, such as cabbage, onions, buckwheat, and rape, are well adapted to such lands when well drained and fertilized.

CHAPTER VI.

GENERAL AGRICULTURE AND CLIMATE.

HISTORY.

As was the case in a large number of Wisconsin counties, the development of Agriculture in Outagamie County was preceded by the logging and lumbering industries.

The first settlement in what is now Outagamie County was made about 1843 by Father Van Der Broeck who had been missionary to the Indians of the region for a number of years. He was instrumental in bringing a colony of Dutch immigrants who located at Little Chute. During this same year, the first buildings were erected in Appleton. The first farms opened after the advance of the lumbermen were small tracts, and often large areas of land remained in the cut-over stage for a considerable time before being parceled out in small farms.

As the timber was first removed from the region adjoining the Fox River, agricultural development had its beginning also in this region.

The crops which were grown by the early settlers were chiefly those which were used for home, or, at least, local consumption, and consisted largely of wheat, corn, potatoes, hay, root crops, etc. The methods which were at first followed were crude and no attempts were made to follow any definite system of rotation or cultivation. Throughout the Fox River Valley the soils are of a heavy nature, and cultivation is more difficult than on the lighter soils. Cultural operations were not thorough. At times the ground was scratched only a little before grain was planted.

While nearly all of the merchantable timber has been removed from this county and a large proportion of the land placed under cultivation, there are still some sections which have considerable undeveloped land. The section least developed is confined to the northeastern part of the county which

was originally included in the Oneida Indian Reservation. In the northwestern portion of the county in Maine, Deer Creek, Bovina, and Maple Creek townships there are considerable areas which are also unimproved due to the fact that in this region there is a large amount of poorly drained land and also some that is of a sandy nature. The greater proportion of the county, however, is highly improved agriculturally.

While practically all of the general farm crops now grown were produced in the early history of the region, the relative importance of a number of crops has changed to a considerable degree. From the various census reports we gather very interesting information along this line. In 1880 there were 40,906 acres devoted to wheat which was nearly three times the acreage devoted to oats, and more than twice the acreage devoted to corn. In 1890 there were only 22,000 acres in wheat, but the acreage of oats had increased to over 31,000. In 1910 the acreage of wheat had dropped to 549 while the acreage of corn was 28,000 and oats 53,000. In 1920 there were 6,748 acres in wheat. In 1880 there were only about 3,000 acres in barley; in 1910 there were over 17,000 acres, and in 1920, 9,600 acres. The following table shows the relative importance of the leading crops over a period of years.

TABLE SHOWING ACREAGE OF LEADING CROPS OVER A PERIOD OF YEARS.

Crop	1880	1890	1900	1910	1920
Wheat	40,906	22,009	15,113	549	7,301
Corn	17,559	11,908	20,344	28,038	21,177
Oats	15,209	31,478	54,680	53,004	46,116
Barley	2,964	3,097	10,229	17,403	9,600
Rye	1,269	4,191	2,961	2,744	2,923
Hay	--------	--------	--------	48,502	59,181

PRESENT STATUS OF AGRICULTURE.

The Agriculture of Outagamie County at present consists chiefly of general or mixed farming with dairying as the most important branch. The chief crops grown according to acreage (taken from the 1920 census) are hay, oats, corn, barley, wheat, potatoes, and rye, with buckwheat, peas, sugar beats, and beans as crops of less importance. During the past few years the acreage of wheat has increased over ten fold. This increase was undoubtedly due to the greater demand for wheat owing to the war situation.

Practically all of the crops grown in this region may be considered in part as cash crops, for hay, corn, oats, rye, and barley are sold to some extent directly from the farms. Potatoes are grown mainly for sale although they are one of the most important subsistence crops. By far the greater proportion of the hay, corn, and oats produced is used in feeding livestock, and thus much of it finally reaches the market in the form of dairy products, beef, and pork. A considerable quantity of grain and hay is used as feed for work stock.

Oats is grown more extensively than any other crop except hay. Its production is distributed throughout the county, and while it is grown on nearly all of the soils, best returns are secured from the fine sandy loams, loams, and clay loams rather than from the soils of lighter texture.

Hay is the crop which is first in importance from the standpoint of acreage. This includes timothy and clover, together or separately, alfalfa, and also such crops as oats, or oats and peas which may be cut green for hay. Only a small proportion of the total hay crop consists of this latter variety, however. Hay makes its best growth on the soils of medium to heavy texture rather than on the light sandy types.

Corn is the crop of third importance from the standpoint of acreage. While corn will usually mature in this section a large proportion of it is used as ensilage since nearly every farmer has a silo. The soils of this county which are best adapted to corn raising are the fine sandy loams which have a rather heavy subsoil, since the sandy surface permits the ground to warm up quite early; so the crop can get a start more readily than on the heavier soils where the drainage is rather deficient, and the ground rather cold in the spring.

Barley is a crop of considerable importance and is grown on a variety of soils.

Rye is confined more extensively to the sandy portions of the county because these soils will produce rye better than any other grain crop.

The growing of potatoes while of some importance has not reached the magnitude which this industry has in either Waupaca or Portage Counties to the west. This fact is due chiefly to the soil in Outagamie County some of which is heavy and not so well suited to the commercial growing of potatoes as are the lighter soils of the other two counties mentioned. In 1920 the

total area was 4,138 acres. Commercially potatoes are confined more extensively to the sandy soils of the northwestern portion of the county. They are also grown to a considerable extent on such soils as the Superior fine sandy loam, rolling phase, which is very well suited to this crop.

There are a number of special crops which are grown to some extent in this county. The most important of these crops is cabbage, grown most extensively in the vicinity of Shiocton. In this region cabbage is grown chiefly on the alluvial soils. The total acreage amounted to 2,550 acres, according to the county report of 1917, with an average yield of 9.8 tons per acre, or a total production of nearly 25,000 tons.

Onions and sugar beets are also grown to a limited extent.

Some trucking is carried on in the vicinity of nearly all the towns, especially in the vicinity of Appleton and Kaukauna, although the soils in that portion of the county are not particularly well suited to this industry. These truck crops consist of cabbage, lettuce, radishes, onions, strawberries, and other vegetables and small fruits.

The following table shows the acreage and production of the important farm crops in Outagamie County.

TABLE SHOWING ACREAGE OF FARM CROPS IN OUTAGAMIE COUNTY, WISCONSIN.

Crop	1909	1919
Corn	28,038 A.	37,840 A.
Oats	53,004	46,116
Winter wheat	246	----------
Spring wheat	287	----------
Wheat	----------	7,301
Barley	17,403	9,600
Rye	2,744	2,923
Buckwheat	334	399
Dried peas	649	277
Tame hay	48,502	49,181
Clover and timothy	----------	47,713
Alfalfa	----------	321
Cabbage	----------	24,990 T.
Beans	138	----------
Wild hay	3,422	----------
Potatoes	4,276	4,138 A.
Sugar beets	403 A.	508
Silos	----------	1,698

The growing of fruit is given comparatively little attention in Outagamie County. The fruit which is produced is grown chiefly for home use. On many of the farms there is a small orchard, which usually supplies apples for home use. Apples

do best over that portion of the county where the surface is somewhat rolling, on such as the rolling phase of Superior fine sandy loam and Miami types. The census of 1920 reported that there were at that time about 51,538 apple trees in the county of bearing age. There were also 7,390 cherry trees of bearing age.

There were approximately 600 grape vines in bearing at that time, and about 72 acres devoted to strawberries.

In this connection the fact may also be mentioned that in 1920 there were about 3,865 maple trees which were being used for the production of maple syrup and sugar.

The raising of live stock is an important industry in this region. Dairying is the most important branch of the live stock industry, but some beef cattle and a large number of hogs are also raised.

Poultry may be mentioned along with the general live stock industry.

Dairying is by far the most important branch of agriculture which is followed in Outagamie County at present. The census of 1919 reported that there were slightly over 56,000 dairy cows in the county. During that year approximately 17,550,000 gallons of milk were produced. The dairy products find their way to market chiefly in the form of cheese, butter, and condensed milk. There is also an appreciable amount of milk which is delivered as whole milk in the towns and cities of the area, and also some whole milk which is shipped to Green Bay.

There is one condensery in New London, just over the line in Waupaca County, which receives a considerable amount of milk from Outagamie County. In 1917, there were twenty-one butter factories and eighty-six cheese factories in the county. Of the dairy cows, those of the Holstein breed are most numerous, and there are a number of pure breds throughout the county although the grades still predominate. The following table shows the number of butter and cheese factories in this county, and also the amounts of cheese which have been produced and marketed.

TABLE FROM WISCONSIN DAIRY AND FOOD COMMISSIONER.

	Butter Factories	Cheese Factories
1910	20	79
1913	19	79
1916	24	81
1918	21	86

	Pounds of cheese produced	Amount received for cheese
1915	9,190,978	$1,246,872.25
1917	9,535,888	2,081,424.32

ADAPTATION OF CROPS TO SOILS.

There is wide variation in the texture of the soils as they are found in Outagamie County, and also a wide range in the drainage conditions. It is generally recognized by farmers that some crops are better adapted than others to various soil types, but not so much attention has been given to the selection of crops and their adaptation to soils in this region as should be. As a result of experiments conducted at the various experiment stations, valuable information has been secured in this connection. In selecting crops to be grown, the question of climate should be considered as well as soil, since in this region the growing season is somewhat shorter than in southern Wisconsin, and with such a crop as corn which is susceptible to frosts, this is a very important matter.

In the growing of corn, the texture of the soil in this region is very important. On the heavy soils, the season is often rather backward; and since the season is rather short, the soils of a somewhat sandy nature are preferred. Probably the Superior fine sandy loam, rolling phase, is one of the best corn soils of this region. At the Spooner Station, the variety of corn known as Wisconsin No. 25 has been found to ripen within one hundred days. This variety is often ripe enough to permit seed selection by August 23d, may be fully ripe August 30th, and yet produced eight to fifteen tons of silage per acre. For seven years No. 25 averaged 57.4 bushels of corn an acre.

In the matter of raising oats, this crop is better adapted to the soils of heavy texture, fine sandy loam or heavier, rather

than to the lighter soils. On the Ashland Experiment Farm, Pedigree No. 4 (Early Gothland) has been found to be a very satisfactory variety of oats to grow. In 1920 this variety outyielded all other varieties, and in spite of a favorable season to favor rank growth, showed very little lodging. So far, early Gothland seems especially well adapted to upper Wisconsin, although one other new strain, No. 1214, has outyielded Pedigree No. 4 by eight bushels an acre on a six-year average. The Ashland Station is on heavy, red clay soil, which is practically the same as the soil in the Fox River Valley.

Wheat is grown to some extent in this region, and could be grown much more extensively with profit. At the Ashland Experiment Station on the red clay land the variety of wheat known as Baska, No. 408, has yielded as high as 51 bushels an acre, or an average of 31 bushels for a seven-year period. The variety No. 11837 yielded 34.2 bushels an acre for seven-year period, and variety No. 11825 yielded 32.4 bushels an acre for the same period. These are all winter wheats, and it has been demonstrated that winter wheats give larger yields and are more profitable to raise than spring wheats. Of the spring grain which have been tried, Marquis seems to give the best results. The well drained red clay lands seem to be better adapted to wheat growing in northern Wisconsin than the other type of soils. In considering these results it should be kept in mind of course that the climatic conditions at Ashland are somewhat different than in Outamagie county, although similar soils are to be found in both regions.

Peas are grown to a greater or less extent in this region, and their production could be materially extended with profit. The varieties which have given the best results at the Ashland Experiment Station on the red clay are the Scotch, which has yielded 22.9 bushels an acre over a period of ten years, and the Green which yielded 22.6 bushels an acre over the same period. Peas pay better and give a larger profit per acre than any of the small grains.

The growing of rye can be made profitable, and this crop is especially well adapted to soils of a somewhat sandy nature; in fact, it does better on the sandy soils than any of the other small grains. Wisconsin Rye, Pedigree No. 2, has given very good satisfaction as grown at the Spooner Experiment Station, as well as in other sections of the state. Winter rye should be

grown instead of spring rye, since the yields are materially higher, the average for several years at the Madison Station giving 44.1 bushels (winter rye), and 23.9 bushels spring rye. The weight per bushel of the winter rye is also somewhat higher than the spring rye. Rye can be grown with profit on heavy soils as well as light soils, but as indicated, it gives better results on the sandy land than the other small grains.

Potatoes where grown on a commercial scale usually give more satisfactory results on soils which are somewhat sandy. Potato growing in Outagamie County is not so highly developed as in Portage or Waushara County, but there are soils here which are very well adapted to this crop. The Superior fine sandy loam, rolling phase, should be especially well suited to potato growing. Very good yields have been secured on the heavy clay lands similar to those in Outagamie County, but the difficulties of growing and harvesting are much greater than on lighter soils.

In regard to root crops, carrots and rutabagas do better than mangles or beets on the light soils. Excellent yields of mangles and beets have been secured on the Superior clay loam. Monarch rutabagas have yielded on an average of 24.57 tons an acre, and the Bangholm rutabagas yielded 21 tons an acre. The Mammoth long red mangle yielded 17.49 tons an acre, and sugar beets yielded 17.87 tons an acre.

The various types of farming are also influenced by soil conditions, and the dairy industry is most highly developed in the region of heavy soils. Agriculture is less developed in the portions of the county where the soils are of a sandy nature.

ROTATION OF CROPS.

In discussing rotations, farm crops may be divided into three classes:

1. Grain crops—generally shallow feeders, add little humus or organic matter, and tend to weediness.

2. Hay crops—legumes, timothy, etc. Legumes have extensive root systems, tap roots, add organic matter or humus and also plant food (nitrogen). They also improve the physical condition of the soil.

3. Cultivated crops—corn, potatoes, etc., conserve moisture, favor decomposition of organic matter, and destroy weeds. Some are deep feeders, as corn, while root crops are shallow feeders.

A good rotation should necessarily include crops belonging to each of these three classes. The value of such practice is apparent in its effect on the physical condition of the soil, on weediness, on organic matter supply, on plant diseases, and on nitrogen supply of the soil. Better yields are, therefore, obtained when crops are rotated than when a single cropping system is followed.

Again, crop rotation permits raising livestock and means diversified farming. No one will deny the benefits of this type of farming in stabilizing farm business and making best use of labor and equipment the year around.

It should not be understood, however, that crop rotation means maintaining the supply of plant food better than where a single cropping system is practiced. It is often said that certain crops are "hard" on the soil in the sense that they remove more plant food than other crops. In part that is true, but a more important difference is that some plants remove more of certain elements than others. Again, a crop like corn, because of its root development and length of growing season, may utilize plant food that is less soluble.

Potatoes require relatively more potassium; corn draws heavily on nitrogen; while legumes are heavy feeders of lime (calcium) and also require large amounts of phosphorus, potassium, and nitrogen (some of which may be extracted from the air in the soil). Again, grain crops and roots require plant food that is readily available, while corn is less particular in this respect.

By properly rotating crops, therefore, the soil is subjected to these different "feeding characteristics". One crop compensates for the other, and there is maintained more nearly a balanced condition than with the single crop system.

It is of great importance that in selecting crops to grow, careful consideration be given to the question of climate. This is about the only factor which the farmer cannot control. A poor soil may be improved, better markets may be found, and better labor secured; but the farmer is powerless to change climatic conditions. He must, therefore, select such crops as are suited to his climate.

The soil is also a factor of great importance. As a general rule, small grain crops do better on heavy than on light soils, and the same is true of grasses grown for hay. On the other

hand, the same variety of corn requires a shorter season for maturity on light than on heavy soil. Rather light soils and those of intermediate texture are better adapted to potato growing.

Shipping and marketing facilities must also be considered in planning a rotation. The farmer located on a sandy loam farm close to a railroad station or home market will often find it profitable to include potatoes in his rotation. If he is located six or seven miles from a station, the profits from growing potatoes will be much lessened. It will then pay him better to raise more corn for stock feeding, and to convert his crops into dairy products which are less bulky, and which for the same bulk have a greater value.

There is no one best system of rotation.* The rotation depends on the system of farming, and this depends largely on the personal choice of the farmer, for some prefer one system and some another. It is highly desirable to rotate crops, but a serious mistake to think that rotation takes the place of other equally sound practices, such as liming and fertilizing.

Following are a few suggestions regarding the selection of rotations for Outagamie County.

1. Rye.
2. Barley, oats, or spring wheat seeded to clover.
3. Clover.
4. Cultivated crop.
5. Peas.

This rotation has been worked out at the Experiment Station Farm at Madison. The following rotation has been worked out at the Experiment Station on sandy soils:

1. Rye, sown as soy beans.
2. Clover.
3. Corn or potatoes.
4. Soy beans.

Other rotations suited to heavier soils consists of

1. Corn.
2. Oats or barley.
3. Clover.
4. Winter wheat seeded to clover.
5. Clover.
1. Clover.

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*See Bulletins 222, 347 Wis. Exp. Station.

2. A cultivated crop.
3. Peas.
4. Winter wheat seeded to clover.

A three-year rotation which is quite commonly used is a cultivated crop, followed by a small grain, followed by clover. This may be changed to a four-year rotation by planting timothy and clover, and cutting hay for two years. This may be changed to a five-year rotation by following mixed hay with peas, and then following peas with a cultivated crop. Potatoes fit in well with a rotation, and in the sandy sections may be grown in rotation with small grain and clover; the second crop of clover is plowed down to supply organic matter.

On the marsh lands as they are reclaimed the question of crop rotation should also be considered. There are three types of farming to which marsh soils are adapted, and these are stock raising or dairy farming, trucking or a combination of the two in which neither type predominates. Grain farming cannot as yet be recommended on marsh soils. Where a farmer has thirty or forty acres of peat he can divide the field into four parts and raise cabbage on one, sugar beets on one, grain on one, and hay on the other. Thus a four-year rotation of hay, sugar beets, cabbage and grain would be practiced on the peat. On a dairy farm, two or three crops of corn may be grown in succession but in this region one should take into account the danger from frost. The corn may be followed by grain, and this by clover and timothy. The hay may be cut the first year and pastured the second. Potatoes may also be grown on peat land but here again the danger from frost must be considered. In some localities outside of this area in this and other states, a one-crop system is being followed where celery, peppermint, or some other crop is the entire source of income. While a rotation of crops on such land is not absolutely essential, a change of crops is desirable to aid in the control of weeds and insect pests.

FARM EQUIPMENT.

Agriculture in Outagamie County is highly developed, and the farm buildings over most of the area reflect the prosperous condition of the farm population. Large, well-painted barns equipped with modern appliances for the handling of dairy cattle, are common throughout the Fox River Valley, and the region covered by the Superior soils. The houses are well con-

structed and painted; many of them are supplied with electric lights, telephone, and rural mail service. In 1920 there were 2,043 silos and 343 tractors in Outagamie County. In the more sandy and less developed sections of the county represented by the districts in the central and north central part, the farm buildings are not so well constructed, neither are they kept in as good repair, as in the Fox River Valley. Even in this region, however, the condition may be considered fair; and it may be said that the fertility of the soil is reflected in the character of the buildings and equipment on each farm.

FARM TENURE AND LABOR.

In 1920 there were 3,746 farms in Outagamie County, the average size of which was 92.9 acres. Of this number of farms only 688 are operated by foreign born farmers; 84.1 per cent of the land in the county is in farms, and of the land in farms 68 per cent is improved. There are on each farm an average of 63.2 acres of improved land.

Of all the farms, 90.81 per cent, or 3,400 farms, are operated by the owners, 42 by managers, and 304 are operated by tenants. Of the farms which are rented, somewhat more than 50 per cent are on a cash rental basis, and the remainder on a share basis.

The census of 1920 reported 2,271 farms in the county upon which there was a mortgage debt. The same report indicated that 1,039 farms were free from mortgaged debt. There was no report on a number of farms.

The supply of farm labor is fairly good. In many cases women and children assist in farm work. When men are hired by the year or month, the wage ranges from $40.00 to $70.00 a month, depending on the experience of the man. Married men are usually given a house in which to live as well as fuel and a garden. During harvest and haying times when extra labor is often needed, the wages are somewhat higher than this, when engaged by the day.

METHODS.

In general, the methods of farming which are followed are practically the same as those practiced throughout the general farming and dairying sections in Wisconsin. The silo is in common use, and about 60 per cent of the corn crop is handled

as ensilage. The hay crop is usually stored in the barn or stacked, and used mainly as feed for stock. In the production of crops, modern machinery is in use, and the tractor is quite common in most parts of the county. It is considered desirable to plow heavy land in the fall if it is possible to do so, but on light, sandy soils spring plowing is preferable. On almost all farms a rotation of crops is practiced, although not always the one which is best suited to conditions prevailing on the farm.

The heavy soils of the Superior series require careful tillage and must be plowed when the moisture conditions are most favorable in order to prevent the formation of clods. Heavy tools and work stock are needed on this land, but when cultivated under proper conditions but little difficulty is experienced in securing a good seed bed.

In the cultivation of marsh soils which are beginning to be improved, the use of a roller for compacting the peat is very important. The roller is also an implement which can be used to advantage on the sandy soils, and the corrugated roller is especially desirable.

LIMING.*

Outagamie County lies in part within the glaciated limestone region of Wisconsin, and a considerable proportion of the soils have been derived in part from limestone material. The subsoil of most of the types is well supplied with lime, and the surface of the soil in many places is neutral or only very slightly acid; in fact, many tests for acidity have been made where the soil does not show any reaction whatever. The types which are most apt to show an acid reaction are soils of the Antigo series, Whitman series, Coloma series, and the peat soils. Where the peat is surrounded by soils of the Superior series, the least acidity in marshes is found.

The degree of acidity is somewhat variable, and each farmer may find a variation in acidity on his farm. It is essential, therefore, that every farm should have his various fields tested before making an expenditure for lime. The county agent can do this, or samples may be sent to the Soils Department of the University where free tests will be made. Failure of clover and alfalfa or a growth of sorrel may be an indication of acidity.

*See Bulletin No. 312 Wisconsin Experiment Station.

About two tons of ground limestone per acre is the usual application where soils show slight to medium acidity. The amount to be used, however, may vary with the degree of acidity, the character of the soil, and the crop to be grown. Such crops as alfalfa, sweet clover, peas, cabbage, onions, and lettuce have a high lime requirement. Clover, garden beans, barley, hemp, turnips, and radishes have a medium lime requirement, while vetch, white clover, oats, rye, blue grass, potatoes, sorghum, and others have a low requirement for lime.

Ground limestone is doubtless the most economical form of lime which can be extensively utilized in Outagamie County. Lime should be applied previous to planting the crop which is to be benefited. It should be applied to plowed land and thoroughly worked in by harrowing. Either fall, winter, or spring applications may be made on heavy soils, but on light soils spring application is preferable.

The best way to apply lime is with a regular spreader made for this purpose, and there are a number on the market. A manure spreader may also be used by first putting in a thin layer of manure and spreading the limestone evenly on top of the manure. Where several farmers are so situated that they can work together, a lime spreader may be secured jointly for this purpose.

After making a first application of two tons per acre, it is not likely that another application will be needed for four to six years, and the need should again be determined by soil acidity tests, as well as by the story which the crops themselves tell.

It should be remembered that most acid soils are also deficient in available phosphorus, but applying lime will not add to the total amount of phosphorus in the soil. The need of phosphorus may be so great that but little result will be secured from liming until phosphorus is also added. Frequently the application of phosphorus alone to an acid soil will result in larger increases than the use of lime alone, and for this reason, it is important that both deficiencies should be corrected to secure the most economical production.

DISTRIBUTION OF LIME, COMMERCIAL FERTILIZER AND MANURE.*

Phosphate or other fertilizers or lime should be uniformly distributed. Ground limestone is applied at the rate of from 2,000 to 4,000 pounds or more an acre, while with phosphates and other fertilizers the amount applied for staple crops is usually from 75 to 400 pounds. It is difficult to construct a machine which will satisfactorily distribute both fertilizer and limestone, although excellent machines are on the market for distributing each separately. The fertilizer distributor may be a part of a grain drill or a separate machine. The machine for distributing ground limestone should be provided with a double agitator so as to secure continuous feeding.

End gate seeders which will distribute proper amounts of either fertilizer or ground limestone fairly well are available.

When a fertilizer distributor is not available the acid phosphate or other fertilizer may be spread evenly over the manure in the manure spreader, and so receive a very fair distribution. This method will give very good results until such time as a grain drill with fertilizer attachment can be purchased. The amount to be applied on each spreader load must be calculated so the right amount per acre will be applied. An old drill or seeder may also be used to distribute the fertilizer going ahead of the grain drill.

The care and use of the manure produced is an important factor in the management of dairy and stock farms. The chief advantage of these types of farming is that the proper use of the manure or other waste products makes it possible to maintain profitable yields with comparatively little purchased fertilizer. But it is only when intelligent care is taken that this result is possible. Much of the available plant food in manure is readily soluble in water, so that if the manure is exposed to the rain in flat or shallow piles, a considerable part of its value is lost. This affects nitrogen and potash especially. It is important also to recognize that a large portion of this element is in the liquid part of the manure and that it is necessary, therefore, to use bedding or absorbents freely to prevent a considerable loss. This is particularly true of potash, about 60 per cent of which is contained in the liquid manure.

*For detailed information on the use of commercial fertilizers see bulletins of the Wisconsin Experiment Station.

Ordinarily the best practice is to haul the manure directly to the field. When this is not practicable the pile should be kept compact, well trodden and moist, as it can be through the use of slightly saucer-shaped manure pit, from the outer sides of which the ground slopes away so as to prevent water washing into the pit itself. In this climate the use of shelter is of doubtful importance, though where more rains occur, particularly in the winter, a shed roof is very helpful.

The rate and frequency with which manure is applied depends in part on the character of the soil on the farm. On lighter soils more frequent applications of small amounts are desirable than on heavier soils. Five or six loads per acre every third year is desirable on the sandy loams, while eight to twelve or more every fourth or even fifth year may be used to advantage on heavier soils.

DRAINAGE.*

Outagamie County has approximately 115,000 acres of land which the soil survey has classed as poorly drained, and which must be provided with some form of drainage before cultivated crops can be grown safely from year to year. Of this poorly drained land, approximately 50 per cent consists of peat, nearly 15,000 acres consists of overflow land classed as Genesee, and the remainder consists of low, poorly drained mineral soils, belonging to the Poygan, Whitman, and Clyde Series. This estimate does not include the Superior clay loam which is a level, heavy soil, needing drainage in places.

The largest areas of undrained land occur in the northwestern quarter and the west central parts adjoining the Wolf, Embarrass, and Shioc Rivers.

At the present time, there are approximately eighteen thousand acres of poorly drained land in operating drainage enterprises. Of this, 5,468 acres are classed as improved, but only 2 to 3 per cent of this improved land is actually in farms. There are 68.4 miles of open ditches with six additional miles under construction. The amount of capital invested in enterprises which have been completed or which are under construction amounts to $167,540.

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*Those who are interested in drainage should apply to the Wisconsin Experiment Station for more specific information concerning their individual problems. Several drainage bulletins are available.

The type of low land which offers the greatest opportunity for drainage is included in the Poygan, Whitman, and Clyde Series. These types of land when thoroughly drained will all make excellent farm land, and conditions are such that most of this land can be reclaimed at a cost which will make the development profitable. The peat soils, on the other hand, require much more careful cultivation and fertilization after drainage, and much of this land also lies tributary to large streams which are sluggish in their movement, and the lowering of which is frequently necessary before the adjoining peat land can be thoroughly drained.

The drainage of some of the peat, therefore, offers obstacles greater than the drainage of the heavier soils. There are considerable areas of peat land, however, which can be readily drained, and on which drainage enterprises are now under way. The completion of these various drainage enterprises will add a large acreage to the tillable land within the county.

Most of the marsh land within the county is still unimproved, and the chief use which is being made of it is for pasture and to some extent for marsh hay.

Where areas of low land include several farms, the owners can readily form a drainage district, and sell bonds to pay for the improvement. This is the method which has been used, and a number of drainage districts have already been established in the county. In this way, the cost of the drainage can be spread over a number of years, and can actually be paid for from the products of the improved acres. Assistance in the development of such projects can, and in fact must, be secured from the state authorities, who pass upon the possibility of the project before the state permits the organization of a drainage district. Where the areas of marsh land are small and confined to one farm, and where there is sufficient outlet, the farmer can install his own tile system without the co-operation of adjoining land owners. This has been done on a number of occasions, yet there are thousands of acres in small tracts which have not been improved.

For a more detailed discussion of drainage, see bulletins 284 and 309, Wisconsin Experiment Station.

CLIMATE.

The climate of Outagamie County is typical of that of east-central Wisconsin. It is healthful, though subject to extreme changes in temperature. The winters are long and severe. The thermometer frequently falls as low as —20° F. The ground freezes to a depth of 1 to 3 feet. Snow usually remains on the ground from December to March or later and protects such winter crops as clover, alfalfa, and wheat. The summers are comparatively short, but pleasant. The thermometer sometimes reaches 100° F. or more. The highest temperature recorded at New London is 104° F., but such extremes are rare. The hottest periods during the summer months seldom continue for more than a few days, and it is unusual for the temperature to remain below zero for more than a week at a time during the winter.

The average rainfall of 32.68 inches is distributed throughout the year, although the precipitation is heaviest during the growing season and lightest in the winter. The average for the summer months of June, July and August is 11.63 inches.

The average date of the last killing frost in the spring, as recorded at New London, is May 10, and that of the first in the fall, September 25. This gives an average growing season of 138 days. The length, however, varies somewhat in different parts of the county, and in the southeastern part of the county, in the region of the Fox River, the season may be 5 to 10 days longer. Killing frost has been recorded at New London as late in the spring as June 12 and as early in the fall as August 30.

In the following table are given the more important climatic data as recorded by the Weather Bureau station at New London:

NORMAL MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT NEW LONDON.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute Maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1916).
	°F.	*°F.*			*Inches.*	*Inches.*
December	20.5	53	—25	1.39	0.82	0.73
January	15.4	52	—31	1.10	1.16	2.89
February	16.1	50	—37	1.28	.84	1.23
Winter	17.3	53	—37	3.77	2.82	4.85
March	29.6	82	—18	2.04	.12	1.79
April	41.5	87	8	2.69	5.89	2.27
May	56.1	91	20	1.41	1.63	5.35
Spring	43.4	91	—18	9.14	7.64	9.41
June	65.8	104	32	3.94	1.16	6.81
July	70.4	102	41	4.35	.78	1.70
August	67.9	97	33	3.34	2.78	3.78
Summer	68.0	104	32	11.63	4.72	12.29
September	60.5	97	19	3.67	4.83	6.40
October	48.8	85	14	2.50	1.30	4.75
November	33.6	71	—14	1.97	2.34	2.70
Fall	47.6	97	—14	8.14	8.47	13.85
Year	44.1	104	—37	32.68	23.65	40.40

SUMMARY.

Outagamie County is situated in the east central part of Wisconsin, between Lake Winnebago and Green Bay. It has an area of 646 square miles, or 413,440 acres.

All of the county drains directly or indirectly into Green Bay. The southeastern corner is traversed by the Fox River, which flows directly into Green Bay. The western part of the county is crossed by the Embarrass, Shioc and Wolf Rivers, the waters of which find their way into Lake Winnebago, and then through the Fox River into Green Bay. The first-named streams are rather sluggish, but the Fox River in a distance of 35 miles has a fall of 170 feet. Many large manufacturing establishments use power developed from this stream.

Farm operations in this county followed closely upon the removal of the timber. All parts of the county are well improved. The northwestern part, which contains considerable areas of Peat marshes and some tracts of sandy soil, is least developed.

All parts of the county are well supplied with railroads, and the wagon roads throughout the county are generally in good condition. Under a State Highway improvement law many gravel and crushed-rock roads are now being constructed. A system of concrete roads, which will ultimately connect the county seat with practically all towns in the county, is one of the most important road projects.

The soils of Outagamie County have been derived from glacial, lacustrine, and alluvial material. In addition, there are large deposits of Peat, consisting of partly decayed organic matter. The soils are classified into 10 series and 24 types, exclusive of Peat.

The Superior series include light-brown soils with heavy, red clay subsoils, occupying areas where the surface is level to rolling. The fine sandy loam, loam, silt loam, and clay loam are mapped in this survey.

The Poygan series consists of dark-colored, low lying, poorly drained soils having heavy, red clay subsoils. In this county the fine sandy loam, silt loam and clay loam are mapped.

The Coloma series includes the light-colored, light textured soils which have been derived through glacial action largely from sandstone. The Coloma fine sand and fine sandy loam are mapped in this county.

The Antigo series consists of light-colored soils which occupy outwash plains or stream terraces where the material has come mainly from crystalline rocks. The types mapped in this survey are the fine sandy loam and loam.

The Plainfield fine sand is similar to the Antigo soils except that it has been derived largely from sandstone material.

The Miami fine sandy loam and loam are light-colored upland soils derived chiefly from glaciated limestone material.

The Whitman series is similar to the Antigo except that the soils are dark colored and contain much larger amounts of organic matter. They are often acid. The types mapped are the fine sandy loam and loam.

The Clyde series consists of low-lying, dark-colored soils occupying old lake beds or stream valleys where the soil material has come largely from glaciated limestone. They are similar to the Whitman soils except that they contain considerable lime carbonate and are very seldom acid. The members of the Clyde series mapped are the fine sandy loam, till phase, and the silt loam, till phase.

The Genesee series consists of brown soils which occupy first bottoms along streams in the glaciated region. They are subject to overflow. The fine sandy loam and silt loam are mapped in this county.

In addition to the above soils, extensive areas of Peat are mapped in Outagamie County. Peat consists of decaying vegetable matter with which there has been incorporated a very small amount of fine mineral particles.

Agriculture in this county consists chiefly of general farming, with dairying as the most important branch. The chief crops grown are hay, oats, corn, barley and rye. Smaller acreages are devoted to such crops as potatoes, cabbage, sugar beets and buckwheat.

Dairy products find their way to market chiefly in the form of butter and cheese. In 1917 there were produced in this county over 9½ million pounds of cheese. There are 21 butter factories and 86 cheese factories in the county.

Holstein cows are most numerous in the dairy herds and all the dairy stock is gradually being improved.

In 1920 there were a total of 3,746 farms in the county, of an average size of 92.9 acres. About 91 per cent of the farms were operated by the owners.

Well-located and highly improved farms have a selling price at present of \$150 to \$250 an acre. Rather sandy soils of low agricultural value have a selling price of \$20 to \$50 an acre, depending upon the location, improvements, soil condition and other factors.

The climate of Outagamie County is representative of a large section of eastern Wisconsin. The mean annual rainfall is 32.7 inches. The average length of the growing season as recorded at New London is 138 days.